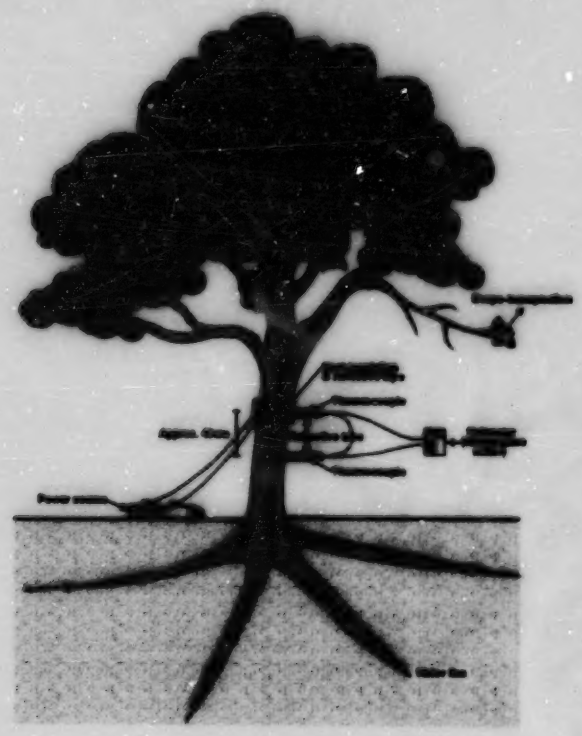
Geochemical Flux in Black Spruce (*Picea mariana*) Crowns and the Correlation With Root Water Uptake: Effects of Sample Site Drainage and Tree and Crown Morphology on Crown Twig and Outer Bark Metal Concentrations



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Schematic diagram of the experimental design of water flow rate measurements apparatus.

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Industry, Trade and Mines
Geological Survey

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Geochemical Flux in Black Spruce (*Picea mariana*) Crowns and the Correlation With Root Water Uptake: Effects of Sample Site Drainage and Tree and Crown Morphology on Crown Twig and Outer Bark Metal Concentrations

by E. Sailerova
Winnipeg, 2000

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APPENDICES

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Appendix 1: Essential elements (Ca, K, Mg, Fe, Mn, P, Zn, Cu) – group A
Elemental content measured in twig ashes and elemental content calculated per one gram of dry weight in twigs and crowns in trees of WS, WB, DS, DB and HB groups. Measurements for individual sampling dates are shown as well as standard deviations for multiple and double samplings. Average values for elemental content, median and seasonal variation (seasonal SD) are also shown.

Appendix 2: Essential elements (Ca, K, Mg, Fe, Mn, P, Zn, Cu) – group A
Correlation between the rate of root water uptake and elemental concentration in twig ashes and tree crown (twig). Sampling dates were four to five days apart and the amount of water uptake (liters) per period was measured. The sampling of three crowns was done at the end of the sampling period. Individual charts for an element and each experimental group (WS, WB, DS, DB and HB) are shown.
- ■ Changes in water uptake during the sampling period
- ● Changes in elemental content in one gram of crown DW during the sampling period
- o Changes in elemental content in twig ashes during the sampling period

Appendix 3: Nonessential elements (Ag, Co, Ni, Rb) – group B
Elemental content measured in twig ashes and elemental content calculated per one gram of dry weight in twigs and crowns in trees of WS, WB, DS, DB and HB groups. Measurements for individual sampling dates are shown as well as standard deviations for multiple and double samplings. Average values for elemental content, median and seasonal variation (seasonal SD) are also shown.

Appendix 4: Nonessential elements (Ag, Co, Ni, Rb) – group B
Correlation between the rate of root water uptake and elemental concentration in twig ashes and tree crown (twig). Sampling dates were four to five days apart and the amount of water uptake (liters) per period was measured. The sampling of three crowns was done at the end of the sampling period. Individual charts for an element and each experimental group (WS, WB, DS, DB and HB) are shown.
- ■ Changes in water uptake during the sampling period
- ● Changes in elemental content in one gram of crown DW during the sampling period
- o Changes in elemental content in twig ashes during the sampling period

Appendix 5: Nonessential elements (Al, As, Au, Ba, Br, Cd, Cr, Cs, Hf, Na, Pb, Sb, Sc, Sr, Th, V, W) – group B
Elemental content measured in twig ashes and elemental content calculated per one gram of dry weight in twigs and crowns in trees of WS, WB, DS, DB and HB groups. Measurements for individual sampling dates are shown as well as standard deviations for multiple and double samplings. Average values for elemental content, median and seasonal variation (seasonal SD) are also shown.

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- ■ Changes in water uptake during the sampling period
- ● Changes in elemental content in one gram of crown DW during the sampling period
- o Changes in elemental content in twig ashes during the sampling period

Appendix 7: Rare-earth elements (REEs) (Ce, La, Sm, Yb) – group C
Elemental content measured in twig ashes and elemental content calculated per one gram of dry weight in twigs and crowns in trees of WS, WB, DS, DB and HB groups. Measurements for individual sampling dates are shown as well as standard deviations for multiple and double samplings. Average values for elemental content, median and seasonal variation (seasonal SD) are also shown.

Appendix 8: Rare-earth elements (REEs) (Ce, La, Sm, Yb) – group C
Correlation between the rate of root water uptake and elemental concentration in twig ashes and tree crown (twig). Sampling dates were four to five days apart and the amount of water uptake (liters) per period was measured. The sampling of three crowns was done at the end of the sampling period. Individual charts for an element and each experimental group (WS, WB, DS, DB and HB) are shown.

- ■ Changes in water uptake during the sampling period
- ● Changes in elemental content in one gram of crown DW during the sampling period
- o Changes in elemental content in twig ashes during the sampling period

Appendix 9: Tree description. Each sampled tree was described according the appearance of the crown, length of the leader, differences in the number of branches, bark quality and tree location (sunny, semi-sunny, shade). Tables are organized according to experimental groups (WS, WB, DS, DB and HB).

Appendix 10: Contains the original analytical data (INAA and ICP-AES analysis) for ashed bark and ashed twigs.

INTRODUCTION

Plants have the ability to select and store metals derived from the growth substrate and distribute them to tissues according to metabolic requirements and tolerances. This ability is being used in biogeochemical exploration. Biogeochemical techniques have been developed and improved for decades. Studies have been undertaken to examine species specific barriers to metal uptake (Kovalevskiy, 1990), partitioning studies to determine the relative abundance of metals in various plant tissues (Fedikow and Dunn, 1996), and laboratory studies of the effect of pH and redox potential on metal utilization in plant tissues (e.g. Redy and Patrick, 1977). This study was designed to improve biogeochemical techniques applied to mineral exploration by: (1) assessing site-specific criteria with potential to seriously affect metal uptake and (2) determining optimum sampling criteria for biogeochemical exploration based on tree morphology and sampling site characteristics.

The absence of a good soil-plant geochemical correlation may be the result of seasonal changes of metal concentrations in the living plant tissue. Seasonal changes are problematic when samples are collected over a prolonged time period. A second concern is tree morphology (size, number of branches, crown type, bark type) and site quality (i.e. drainage, tree density). This study was designed to address these problems. Water flux in trees was measured throughout the period of study to distinguish between seasonal metal flux attributable to changes in the tree physiology and geochemical flux induced by differences in root water uptake.

Black spruce (*Picea mariana* (Mill.) BSP) is the most common tree species in the study area. Crown tissues and outer bark were selected as the principle sample types because of ease of collection and acropetal tendency for metals to concentrate in crown tissues.

EXPERIMENTAL GROUPS AND SAMPLE COLLECTION

One hundred black spruce (*Picea mariana*) crowns and outer bark samples were collected from three different sites. Trees growing on two of these three sites were separated into two sub-groups according to the number of transpiring branches. This provides five different experimental groups from which twenty crown and bark samples were collected. Samples were collected between June 6 and July 31, 1996 in four to seven day intervals resulting in eleven sampling dates for each experimental group. Duplicate and replicate (five samples) sampling was undertaken during the season for each experimental group in ten to twelve day intervals. Sampling was restricted to trees with a circumference of 34-39 cm (measured at chest height). Tree crowns were cut at a constant 45 cm distance measured from the leader base. Crowns were characterized according to whether they were: (1) packed or loose, (2) wide or narrow and (3) by the length of the leader. Outer bark was collected from chest height and characterized as coarse, semi-coarse or fine. The location of each tree was noted according to the availability of direct sunshine (sunny, semi-sunny or shade). The age of each tree was determined by tree ring counts in wafers cut from the tree at 20-30 cm above the ground.

All three experimental sites were located close to the Manitoba Hydro damsite near Jenpeg (Fig. 1). The distance between experimental sites was up to 700 meters. Black spruce was the predominant vegetation type on each site with sporadic tamarack (*Larix laricina*). Site W, the first experimental site, was swampy, remaining wet throughout the measuring season and contained variably decomposed forest litter. The second experimental site (site D) was well drained and remained dry during the season. The third site (site H) was only partly drained reflecting most typical conditions of those encountered during the measuring season. Black spruce trees growing on site H were shorter with a relatively high number of transpiring branches. The density of trees growing on site H was about three times higher than either sites D or W. The transpiration rate from bottom branches was expected to be limited by solar radiation and lowered by the higher surface layer diffusion resistance.

Trees growing on sites D and W were separated into two experimental groups. The first group (group S) contained trees with small transpiring surfaces representing seven to twenty transpiring branches. Trees from the second group (group B) had twenty to forty transpiring branches, which were approximately fifty percent longer than those belonging to S group. Accordingly, group B trees had approximately three times the transpiring surface as compared to trees from group S. The transpiring surface of trees growing on site H was similar to the trees from group B (twenty to forty branches) and as such was labeled as group B as well. The designations and site characteristics of the experimental groups are provided in Table 1.

The age of the sampled tree, as estimated by tree ring counts, was similar for all experimental groups. The WS trees averaged 96.1 years (SD=2.3), DS trees were 97 years old (SD=2.4), WB trees were 92.3 years old (SD=4.4), DB trees were 96 years old (SD=3.9) and HB trees were 93.9 years old (SD=4.5). The range of all tree ages was 84 to 104 years.

SAMPLE PREPARATION AND ANALYSIS

Black spruce crown and outer bark samples were air-dried and the crown separated into twig, needle and cone portions. One third of the twig samples in each experimental group, collected in the beginning, in the middle and at the end of the season, were separated into thin and thick twigs and the element content analyzed separately. Volumetrically, thin twigs had 1 to 3 times more bark compared to the woody part with maximal radial diameter of 4 mm. Thick twigs with diameters >4 mm contained a higher portion of wood compared to bark. One third of all the cone samples were separated into closed cone and open cone samples and analyzed separately. Remaining cone samples were characterized

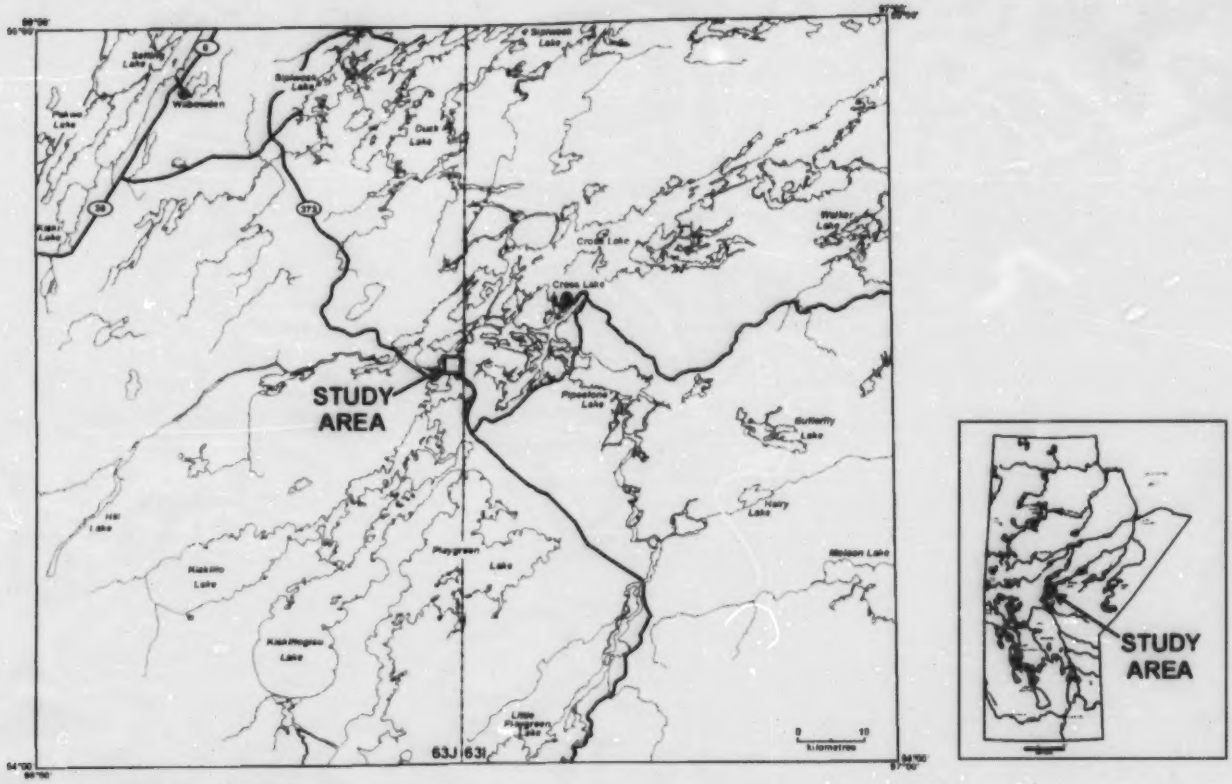

Figure 1: Location map of the study area.

Table 1: Designations and characteristics of experimental groups	
WS	trees growing on poorly drained site covered with pond water during the whole season; trees had small number of branches (7 to 20) and thus small transpiring surface; density of the trees growing on this site was low
DS	trees growing on well drained site; trees had small number of branches (7 to 20) and thus small transpiring surface; density of the trees growing on this site was low
WB	trees growing on poorly drained site covered with pond water during the whole season; trees had large number of branches (20 to 40) and thus large transpiring surface; density of the trees growing on this site was low
DB	trees growing on well drained site; trees had large number of branches (20 to 40) and thus large transpiring surface; density of the trees growing on this site was low
HB	trees growing on partially drained site, where the pond water remained up to 5 days after rainy period; trees had large number of branches (20-45) and thus large transpiring surface; higher density of trees on this site resulted in lower evapotranspiration rates from the lower branches attributable to limited irradiation

by the ratio of open and closed cones on a volume basis. The dry weight of each twig, cone and needle sample was recorded prior to ashing. Care was taken to collect all the twigs, needles and cones, so that the dry weight ratios would represent the true crown organ ratios for each crown sample.

Analysis of element content in all crown organs (i.e. thin and thick twigs, open and closed cones and needles), along with the description of crown appearance (twig, cones and needles ratio) in samples collected during the season was undertaken to analyze the seasonal element redistribution in the crown. We anticipated that this data might also show the effect of crown appearance on the twig element concentration (i.e. dependency of the element distribution factor between needles and twigs based on their relative amount). The same data set enables an accurate calculation of crown element content, which should correlate more strongly to root water uptake than twig element content. Unfortunately, only the data from twig analysis were available at the time of completion of this study. To minimize the differences in elemental twig content due to morphological differences in the crown collected during the field season and to demonstrate the correlation of element concentration in the crown with the root water uptake, a projected crown element concentration was calculated as shown in the Data Analysis section. A time-independent ratio between twig, cones and needles was assumed. The needle and cone elemental content was calculated separately for each crown using the

organ dry weight and published element distribution ratios for twigs/needles, twigs/cones, closed cones/open cones and ash content ratios in actual and analyzed samples. The elemental crown organ distribution ratios originate from a single comprehensive data set for black spruce crowns collected by Fedikow and Dunn (1996).

Analytical results for only five of twenty bark samples collected from each experimental group were available at the time this report was prepared.

Twig and bark samples were ashed in a pottery kiln in the laboratories of the Geological Survey of Canada (Ottawa) under the supervision of Dr. Colin Dunn. Ashes were analyzed by inductively coupled plasma atomic emission spectrometry (ICP-AES) and instrumental neutron activation analysis (INAA). Results from ICP-AES analysis for Ag, Cd, Cu, Mn, Ni, Pb, Zn, Al, Mg, P, Sn, Sr, Ti, V, Y, W, Zr and from INAA for Au, As, Ba, Br, Ca, Co, Cr, Cs, Hf, Fe, K, Na, Rb, Sb, Sc, Th, U, Zn, Eu, La, Lu, Nd, Ce, Sm, and Yb were used for this study. Elements Tb, Ta, Se, Mo, Ir, Sn, Se, Bi, Be and Hg were below the limits of determination for this study and are not discussed further. Analyses were undertaken by Activation Laboratories Ltd. (Ancaster, Ontario).

ROOT WATER FLOW RATE MEASUREMENTS

Water and solutes are absorbed by tree roots and transported through the tree xylem to the transpiring surfaces. This water flow rate was measured at the tree trunk level approximately 0.5 m above the ground. Two trees for each experimental group were monitored with water flux measured over a period of three to five days in one to two hour intervals, between 7:00 a.m. and 12:00 p.m. Weather conditions were monitored simultaneously and later compared to and supplemented by the official weather report from the Environment Canada weather station located in Norway House (about 80 km from the experimental sites). Daily water flow rate curves were calculated for two basic weather conditions: (i) for a clear sky or partly overcast and moderate to strong wind conditions and (ii) for overcast or partly overcast without wind.

Method

Principle

A known amount of heat is applied to the tree trunk xylem. Part of the applied heat is carried away by the water flowing through the xylem. The higher the water flow rates, the lower the resulting temperature in the heated spot. The temperature changes are measured differentially against the reference temperature in an unheated part of the trunk xylem.

Experimental design

The outer bark and phloem tissue were carefully cut and exposed in an approximately 7 cm wide strip partly separated from the xylem tissue (trunk wood, Fig. 2). This part of the trunk was tightly circled by heating wire with known resistance that was connected to a portable power source. The heated part of the tree trunk was isolated by several layers of insulating material covered by reflective tape to prevent any heat loss or temperature increase due to sunshine. A heavy duty copper/constant thermocouple, inserted in a 15 cm long protective metal coat, was placed in the center of the heated spot, with the temperature sensitive connection located in the center of the trunk. A second thermocouple, monitoring the reference temperature, was placed 40 cm below the first thermocouple with the temperature sensitive connection also in the middle of the trunk. Both thermocouples were protected from the direct sunshine by reflective tape. The temperature difference was measured by a specially calibrated voltmeter that enabled direct temperature readings. The voltage of the power source was monitored as well as the temperature measurements. An equilibration period of 12 hours was required. The design of the apparatus is shown in Figure 2.

Trees were cut and the crowns sampled 10-30 days after the measurements. During this time period the phloem pathway to the roots was disconnected, while the xylem pathway remained intact. Trees thus continued to receive nutrients and metals but the transport back to the roots was eliminated. The resulting increase in the element crown content was termed "element phloem buildup".

DATA ANALYSIS

Element Concentration in Different Crown Organs

The elemental concentration in crown twigs (TW), needles (N), cones (C) and crown (CR) was calculated using the measured parameters as well as "model black spruce tree" parameters as determined by Fedikow and Dunn (1996):

Measured parameters:

element concentration in twig ash.....E(ash)
twig ash content.....A
open cones/closed cones ratio.....k
twig weight.....Wt
needles weight.....Wn
cones weight.....Wc

Parameters analyzed for a "model black spruce tree" - L76N, 25W (Fedikow and Dunn, 1996):

needles ash content/twig ash content.....Kn
cones ash content/twig ash content.....Kc
open cones ash content/closed cones ash content...Koc
elemental concentration in needles ash/element concentration in twig ash.....Cn
elemental concentration in cones ash/element concentration in twig ash.....Cc

Equations utilized for this study assuming negligible element losses during ashing (Dunn, 1995):

elemental concentration in twigs: $TW=E(ash)*A/100$
elemental concentration in needles: $N=TW*Cn*Kn$
elemental concentration in cones:

$$C=TW*(Cc*Kc*k*Wc*Koc/(k+1) + Cc*Kc*Wc*Koc/(k+1))/Wc$$

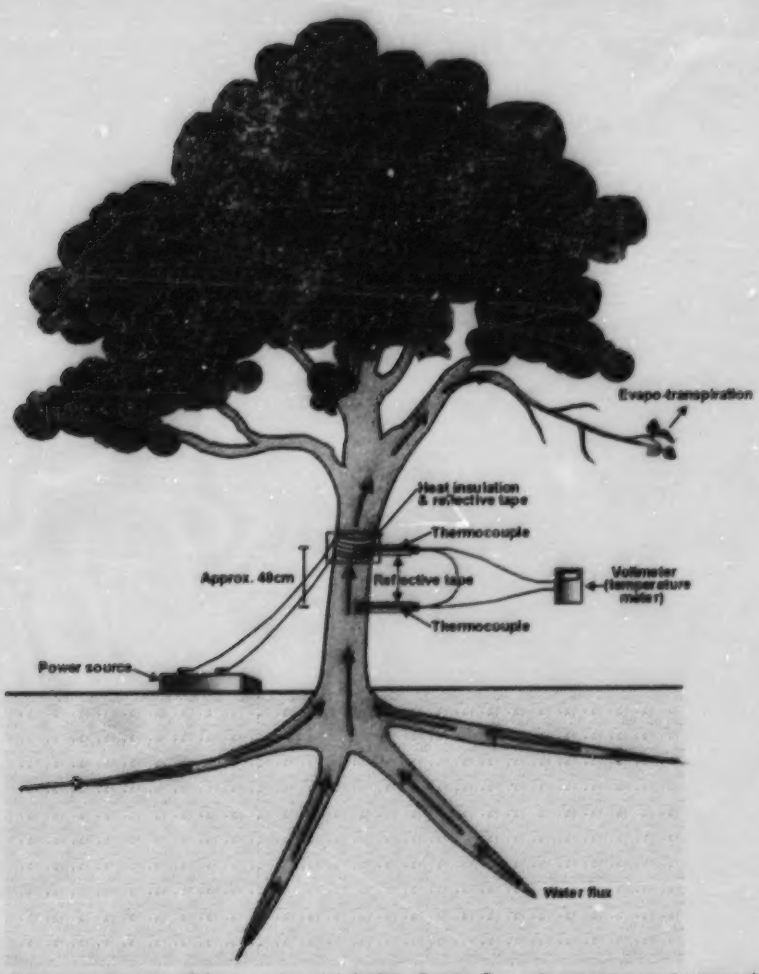

Figure 2: Schematic diagram of the experimental design of water flow rate measurements apparatus.

elemental concentration in crown:
CR=(TW*Wt+N*Wn+C*Wc)/(Wt+Wn+Wc)
elemental concentration in twigs and cones:
TW+C=(TW*Wt+C*Wc)/(Wt+Wc)
elemental concentration in twigs and needles:
TW+N=(TW*Wt+N*Wn)/(Wt+Wn)
elemental concentration in cones and needles:
C+N=(C*Wc+N*Wn)/(Wc+Wn)

The standard deviation (SD) was calculated for four multiple samplings on one sampling date per each experimental group. The average SD was calculated for these three SD values and thus does not reflect seasonal changes. The seasonal SD (n=11) reflects the variation of the specific parameter during the season.

Calculation of the root water flow rate (Fw):
Heat supply to the tree trunk xylem: $Q_1=U*I*t=U^2*t/R$
Heat carried away by water flux: $Q_2=m*c*(T_1-T_2)=V*d*c*(T_1-T_2)$
At equilibrium when T_1-T_2= constant , $Q_1=Q_2$ and
Water flow rate through the tree trunk (F) $F=V/t$ $[m^3*s^{-1}]$
then $F=U^2/(R*c*(T_1-T_2))$
$Fw=F-F_0$

F_0 (const) was calculated as the F value measured at conditions when water flow rate assumed to be zero (dark night, after rain conditions) and represents the heat losses and cuticular transpiration, assumed to be negligible in conifers.
where:

U.....voltage on the power supply
I.....electric current
R.....resistance of the heating wire (29.5 ohm)
c.....specific heat of water
T_1.....temperature measured at the spot heated by the heating wire
T_2.....temperature measured at the reference spot
t.....time
d.....water density
V.....volume

Root water flow rate was measured at one hour intervals for each tree and the water flux per day calculated for two weather conditions as described above. Water flux per sampling period varies according the number of sunny and rainy (overcast) days.

Phloem Buildup

Water and solutes are transported to the crown and transpiring branches through the xylem tissue. From transpiring and photosynthesizing tree organs, a stream of solutes is transported back to the roots through the phloem tissue, providing the roots with necessary energy. Along with a variety of energy-rich products, elements that were not utilized or redistributed in the tree shoot are transported to the roots as well. High phloem buildup values indicate that higher element concentrations have been transported either to the roots or to the rest of the tree shoot, branches or trunk. The phloem solute transport route was disconnected for 10 - 30 days in trees where water flow measurements took place. Changes in the crown (twig) element concentration was calculated as a difference between crown (twig) element concentration and crown (twig) element concentration in trees sampled the same day with the phloem pathway intact.

RESULTS

Root Water Flow Rate

Trees with low numbers of of transpiring branches (WS and DS) and thus small transpiring leaf (needle) areas growing on wet and well drained sites showed little difference in daily flow rate profile (Figs. 3, 4). Differences in water flow rates on sunny and overcast days (Figs. 3 to 8), confirm the stomatal response as a determining factor in water flow rate regulation. About 2.5 times more water was flowing through the xylem of trees with a higher number of branches (WB, DB) compared to WS and DS trees (Figs. 5, 6, 8), which corresponds with the ratio of transpiration area in these trees. Smaller differences in the water flow rate on sunny and overcast days was measured in trees of the WB group (66.6 and 42.7 liters per day, respectively) compared to trees of the DB group (71.4 and 27.5 liter per day, respectively). This indicates a more significant role of the stomatal regulatory system in trees growing on well drained sites. Lower daily water flux along with a lower difference on sunny and overcast days in trees of the HB group (53.6 and 41.2 liter per day, respectively, Fig. 7) is most probably a result of high tree density on site H and thus limited irradiation of lower branches. Saturation irradiance levels in black spruce are relatively low and shaded branches will respond to different weather conditions only on the basis of air humidity and wind strength changes.

Element Concentration in Black Spruce Crown and Outer Bark

Analyzed elements were separated into four basic groups. The first group (group A) contains essential elements and group B contains pH sensitive elements. Group C contains the rest of analyzed elements including the rare-earth elements (REEs). Group D represents Ti, U, Y and Zr. Designations and characteristics of experimental groups are summarized in Table 1. Summaries for all elements (essential and nonessential A,B,C and D) are given in Tables 2, 3, 4 and 5. These tables give the average element content in twig ashes for thin and thick twigs, average values and ranges for ash, twig and crown element concentration measured during the season, and average values of estimated phloem daily buildup shown as a change in % or ppm in crown or twig content per day. For a quick evaluation of the extent of seasonal changes, a "seasonal category" is included. This evaluation is based on the relative value of seasonal SD and average SD measured in multiple same-day samplings. For seasonal category 1 seasonal SD is less than or equal to the SD of multiple samplings. Seasonal category 2 indicates the seasonal SD is greater than the SD of multiple samplings. Seasonal category 3 indicates the seasonal SD is greater than 2xSD of multiple samplings. The quality of correlation between the root water uptake with the element content in the crown twigs and the whole crown is labeled as 0 (poor), 1 (satisfactory) and 2 (excellent). Finally, the average, median and SD values of element content in outer bark ashes are given in Tables 6, 7 and 8. Tables 9, 10, 11 and 12 demonstrate the differences in elemental concentrations between twigs and bark.

Appendices contain data illustrating the seasonal changes in element concentration in twig ashes (ash), twigs (TW) and crown (CR) in trees of the WS, DS, WB, WB and HB group. Tables for individual elements along with sampling dates standard deviation values for multiple samplings and seasonal and analytical method SD were calculated for each experimental group and each element. For trees with double crowns the SD values are also shown. These data are presented in Appendix 1 (group A), Appendix 3 (group B), Appendix 5 (group B) and Appendix 7 (group C). Due to a lack of available data in our "model tree" for some elements, the crown element concentration could not be calculated. The SD related to the analytical method reproducibility was 2 to 30 times lower than average SD for multiple samplings. The element content differences measured for a double crown (found mostly in DB trees) were similar to the differences within multiple samplings.

Figures illustrating the correlation between the amount of water uptake during the sampling period and corresponding changes in the element concentration in crown and twig ashes during the measuring season are located in Appendix 2 (group A), Appendix 4 (group B), Appendix 6 (group B) and Appendix 8 (group C). The crown element concentration was replaced by twig element concentration when missing data for the "model tree" made the calculation impossible. A substantially better correlation between root water uptake and crown element content compared to twig ash element content was found for the majority of studied metals.

In general, no differences were found in crown element content between trees with a high and low number of transpiring branches, although the difference in the amount of water accepted by those trees was substantial (Fig. 7). Differences between selected experimental groups were all attributable to the differences in site drainage and some to the site tree density. Elements

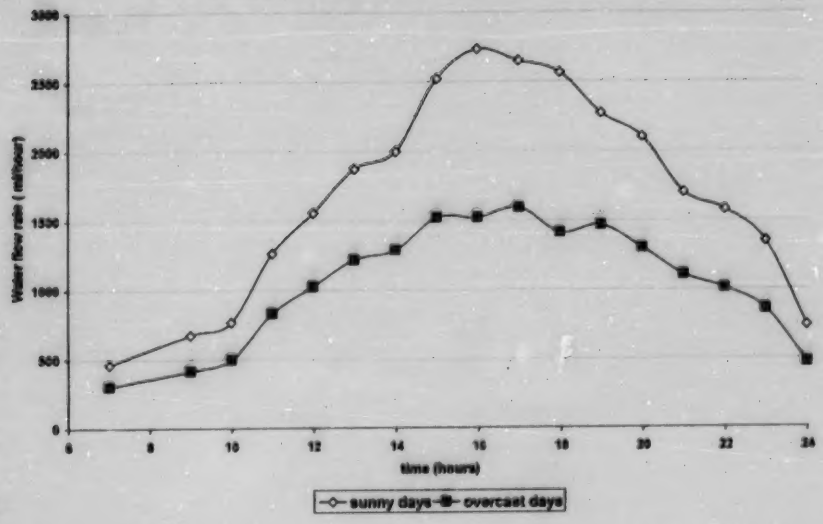

Figure 3: Daily root water flow rate profile - WS.

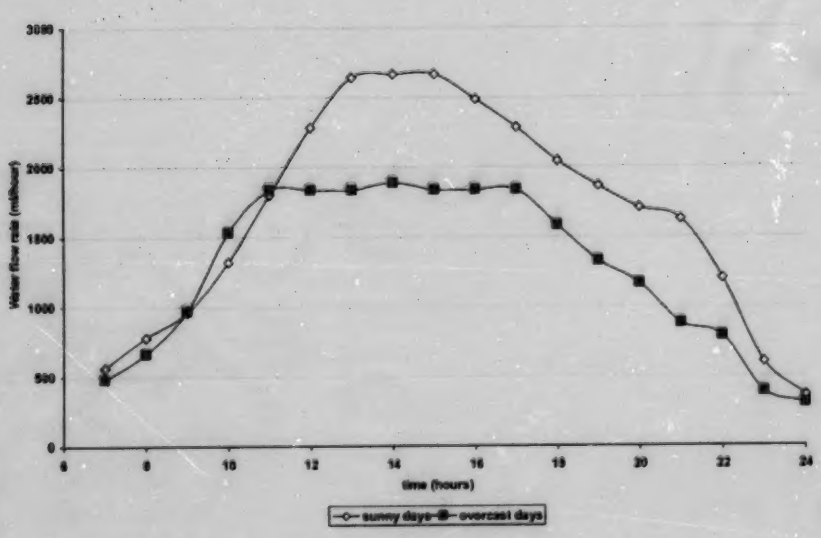

Figure 4: Daily root water flow rate profile - DS.

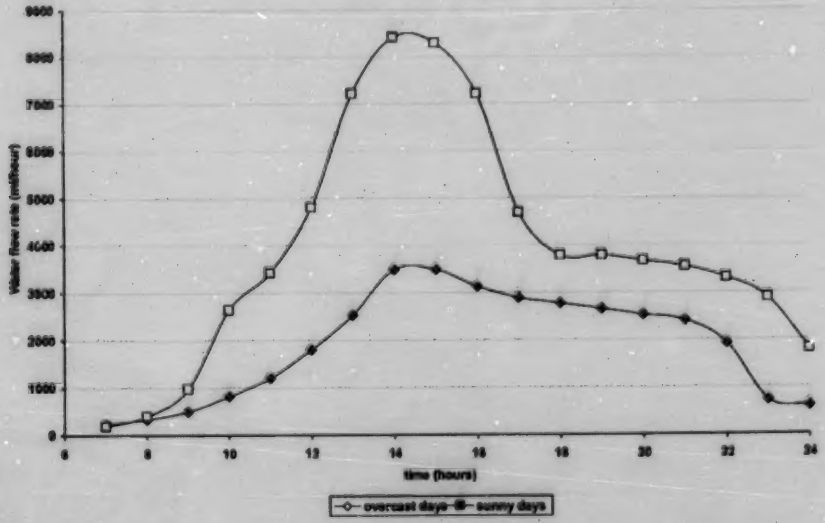

Figure 5: Daily root water flow rate profile - WB.

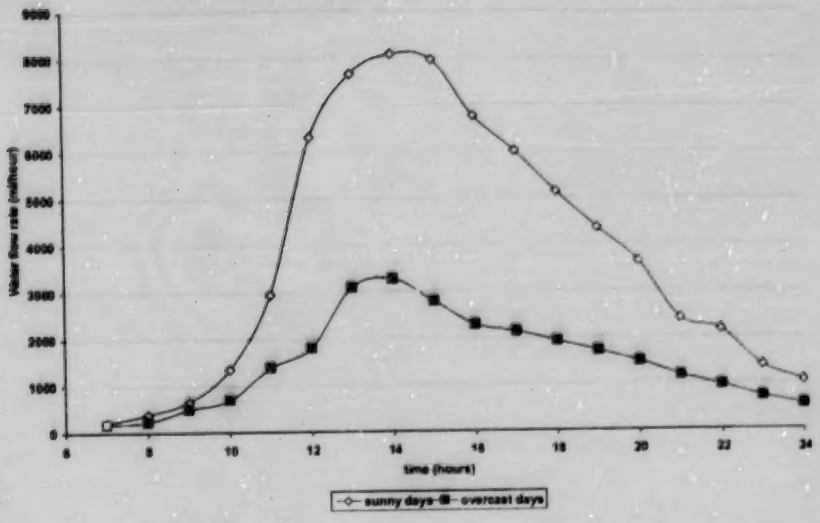

Figure 6: Daily root water flow rate profile - DB.

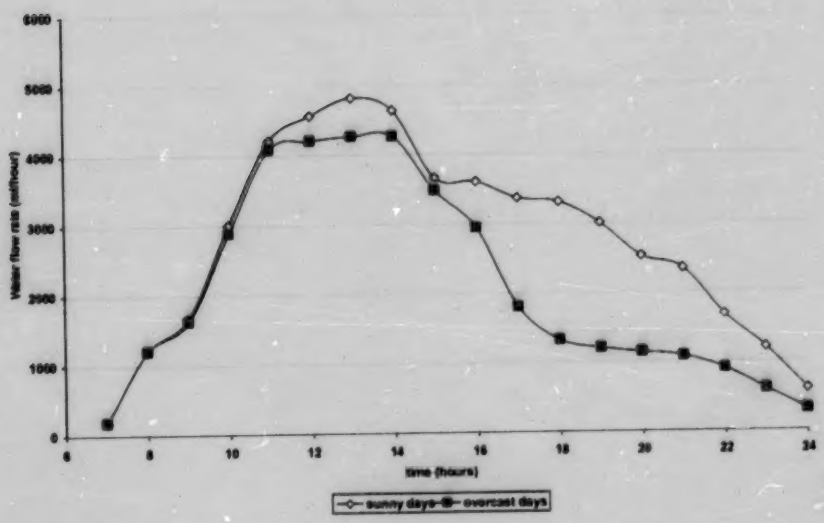

Figure 7: Daily root water flow rate profile - HB.

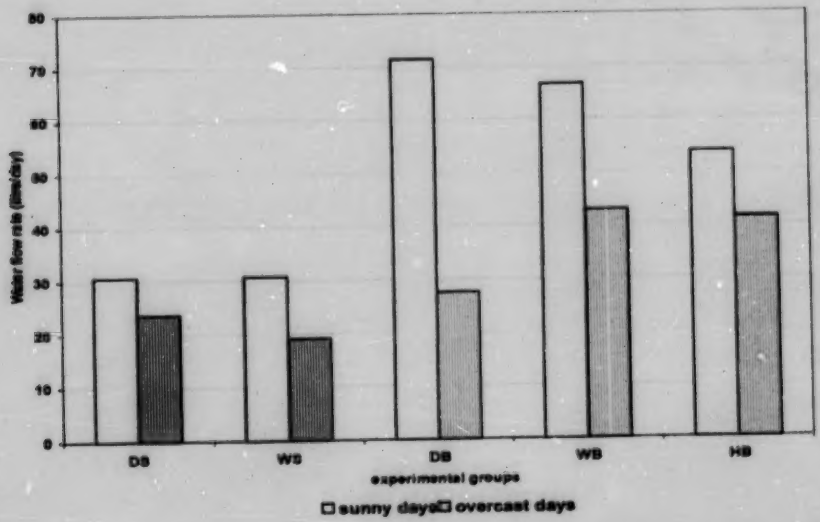

Figure 8: Average daily root water flow rate.

Table 2: Group A elements in black spruce crowns in WS, DS, WB, DB and HB trees. Element content in thin and thick twigs, seasonal averages, phloem buildup values in crown (twigs) and evaluation of the correlation between the crown element content and root water uptake.

element content in twig ash				seasonal average			element content range			seasonal category			phloem build-up	correlation with the root water uptake	
		thin (%)	thick (%)	ash (twig) (%)	twigs (%/DW)	crown (%/DW)	ash (twig) (%)	twigs (%/DW)	crown (%/DW)	ash (twig)	twigs	crown	CR (TW) (%of CR conc./day)	ash	CR (TW)
Ca	WS	16.8	20	17.32	0.357	0.211	14.9-22.1	0.32-0.44	0.162-0.273	1	2	3	-1.32E-01	0	2
	DS	16.6	19.2	16.39	0.352	0.239	13.0-19.2	0.29-0.42	0.183-0.340	2	2	1	-1.87E+00	0	0
	WB	18.2	20	17.94	0.415	0.27	15.5-19.6	0.152-0.334	0.152-0.465	1	1	1	-7.49E+00	1	2
	DB	16.5	19.6	17.75	0.382	0.279	13.6-19.9	0.276-0.462	0.169-0.390	1	2	1	-2.13E+00	0	0
	HB	15.8	17.8	16.64	0.361	0.232	14.3-19.6	0.285-0.470	0.139-0.351	1	2	2	-9.13E+00	0	1
K	WS	18.9	19.5	19.23	0.397	0.344	14.37-23.76	0.267-0.585	0.264-0.484	2	1	2	-2.12E+00	0	1
	DS	20.8	20.4	19.34	0.418	0.434	14.3-26.7	0.328-0.595	0.182-0.562	3	2	3	1.11E+00	1	2
	WB	16.8	17.3	18.16	0.426	0.405	13.2-25.4	0.329-0.772	0.231-0.872	2	2	2	9.30E-01	0	1
	DB	13.5	18	16.89	0.365	0.414	13.2-20.0	0.302-0.471	0.278-0.659	1	2	2	-9.35E-01	0	0
	HB	16.9	16.5	16.66	0.404	0.372	13.85-23.93	0.301-0.536	0.210-0.513	2	2	2	-3.80E+00	0	2
Mg	WS	5.7	6.2	5.33	0.108		2.98-7.64	0.063-0.147		3	2		2.25E+00	1	1
	DS	4.08	4.08	4.26	0.092		3.08-5.68	0.069-0.127		1	2		3.92E+00	0	0
	WB	4.77	5.04	5	0.118		2.86-7.62	0.078-0.177		1	1		4.96E+00	1	1
	DB	6.5	5.7	4.59	0.098		2.78-5.53	0.057-0.130		1	2		2.19E+00	0	0
	HB	5.6	6.3	5.27	0.114		3.52-7.6	0.064-0.133		2	1		1.64E+00	1	1
Fe	WS	0.45	0.35	0.36	0.00769	0.00337	0.27-0.43	0.0066-0.0097	0.00223-0.00686	2	1	3	5.57E+00	0	0
	DS	0.45	0.4	0.396	0.00848	0.00366	0.24-0.71	0.0053-0.0149	0.0022-0.00625	1	1	1	1.16E+01	0	0
	WB	0.41	0.27	0.266	0.00673	0.00264	0.18-0.355	0.0052-0.0063	0.00175-0.00398	1	1	1	-9.98E-01	1	2
	DB	0.38	0.32	0.33	0.00727	0.00312	0.21-0.5	0.0055-0.0096	0.0021-0.0044	3	2	3	1.70E+00	0	2
	HB	0.49	0.31	0.389	0.00847	0.00197	0.28-0.54	0.0059-0.0112	0.0021-0.0051	1	1	1	2.27E+01	0	2
		(ppm)	(ppm)	(ppm)	(ppm)	(ppm)	(ppm)	(ppm)	(ppm)				(%of CR conc./day)		
Mn	WS	4749	4733	4785	96.8		3410-5715	72.3-131.4		2	2		2.15E+00	0	0
	DS	11656	11248	10712	233.1		8375-17100	154.8-415.5		2	2		3.37E-01	1	1
	WB	4831	5739	5531	124.6		1470-7310	44.7-174		2	2		-9.66E-01	1	1
	DB	12808	12100	11373	250.9		4897-13448	135.5-326		3	3		1.18E+00	0	0
	HB	5592	5702	5029	113.6		2965-8400	67.2-169.6		3	2		-6.80E+00	1	1
P	WS	44275	32526	38021	803		21501-23500	570-1139		2	3		2.48E+00	0	0
	DS	46320	32080	37418	816		21974-50100	606-1117		2	2		2.60E+00	1	1
	WB	43375	33600	35799	836		22775-46100	491-1025		2	1		3.96E+00	0	0
	DB	44130	30060	33374	741		25072-38919	498-949		2	2		2.89E+00	1	1
	HB	33303	29217	34334	757		21106-44000	417-1066		2	2		6.06E+00	0	0
Zn	WS	2236	2075	2056	42.96	19.38	1368-2900	31.8-61.2	13.96-38.96	2	2	3	6.35E+00	0	0
	DS	2020	1900	1734	37.5	17.6	1242-2100	23-42.37	12.17-22.93	2	2	2	4.52E+00	1	2
	WB	2212	1988	1795	41.8	18.8	1544-2200	32.5-51.7	10.34-30.20	2	2	2	5.75E-01	0	0
	DB	1700	1580	1610	34.6	16.9	1242-2200	25.4-47.2	12.46-23.58	2	2	2	5.09E-01	1	2
	HB	2316	1850	1859	41.9	19.3	1400-2400	18-58.6	7.92-27.05	2	2	3	1.72E+00	0	0

Table 2: Group A elements in black spruce crowns in WS, DS, WB, DB and HB trees. Element content in thin and thick twigs, seasonal averages, phloem buildup values in crown (twigs) and evaluation of the correlation between the crown element content and root water uptake. (continued)

element content in twig ash				*seasonal average*			*element content range*			*seasonal category*			*phoem build-up*	*correlation with the root water uptake*	
		thin (%)	thick (%)	ash (twig) (%)	twigs (%/DW)	crown (%/DW)	ash (twig) (%)	twigs (%/DW)	crown (%/DW)	ash (twig)	twigs	crown	CR (TW) (%of CR conc./day)	ash	CR (TW)
Cu	WS	152	142	137.6	2.87		99.8-166	2.05-3.55		1	1		2.37E+00	0	0
	DS	225	205	211.2	4.54		172-366	3.479-7.32		2	2		2.48E+00	0	0
	WB	154	155	154	3.56		92.7-220	2.307-4.87		1	2		3.84E+00	1	1
	DB	203	201	191.3	4.18		148-208	3.145-5.96		3	3		6.50E+00	2	2
	HB	145	130	123.8	2.74		74.6-158	1.476-3.79		3	2		1.85E+00	1	1

Arithmetic mean (n=11) of metal content in ashes of thin (up to 4 mm diameter) and thick twigs; metal content in twigs and crowns based on the twig, crown dry weight.
The range for metal concentrations measured in twig ashes, twigs (DW) and crowns (DW) is shown.
Seasonal category 1 indicated that SD for multiple samplings is higher than seasonal SD; category 2 indicated that seasonal SD is higher than SD for multiple sampling, but does not exceed twice the value.
Category 3 indicates very high seasonal variations, where seasonal SD exceed more than twice the SD of multiple sampling.
The rate of phloem build-up is shown as a percentage of the crown element concentration per day.
The quality of element concentration in twig ashes and in the crown with the root water uptake is qualified as poor (0), good (1) and excellent (3).

Table 3: Group B elements in black spruce crowns in WS, DS, WB, DB and HB trees. Element content in thin and thick twigs, seasonal averages, phloem buildup values in crown (twigs) and evaluation of the correlation between crown element contents and root water uptake.

element content in twig ash				seasonal average			element content range			seasonal category			phloem build-up	correlation with the root water uptake	
		thin (ppm)	thick (ppm)	ash (twig) (ppm)	twigs (ppm/DW)	crown (ppm/DW)	ash (twig) (ppm)	twigs (ppm/DW)	crown (ppm/DW)	ash (twig)	twigs	crown	CR (TW) (%of CR conc./day)	ash	CR (TW)
Ag	WS	1.2	1.54	0.761	0.0155	0.0045	0.6-1.021	0.0116-0.0156	0.0031-0.0049	1	2	2	-3.38E+00	0	1
	DS	0.733	0.877	1.278	0.0274	0.00252	0.884-2.2	0.0204-0.044	0.0062-0.0164	3	2	2	-9.94E+00	0	0
	WB	0.775	1.05	0.837	0.0191	0.00141	0.4-1.2	0.0067-0.0286	0.002-0.0097	1	1	1	-1.29E+01	0	1
	DB	1.42	1.74	1.403	0.0303	0.0096	0.85-2.4	0.0197-0.0493	0.0041-0.0196	2	2	3	-5.95E-01	0	1
	HB	0.73	1.11	0.706	0.016	0.00141	0.4-0.851	0.0098-0.0208	0.00097-0.0087	2	2	2	-8.87E-01	0	1
Co	WS	4.6	5.1	4.278	0.0872	0.0386	3.222-5.169	0.0736-0.1118	0.031-0.0651	1	1	3	3.24E-01	1	1
	DS	15	16.4	13.7	0.2956	0.1322	10.0-18.0	0.0226-0.4374	0.0705-0.1744	1	1	1	4.04E-01	0	0
	WB	3.5	3.5	3.826	0.0876	0.039	2.669-9	0.0576-0.207	0.0234-0.1074	2	2	3	4.61E+00	0	1
	DB	11.2	11.8	10.74	0.2312	0.1099	5.103-22	0.1142-0.4598	0.0463-0.2242	3	3	3	9.22E-01	0	0
	HB	3.8	3.1	3.907	0.0853	0.0384	2.698-5	0.054-0.1075	0.0205-0.0518	1	2	2	4.56E-01	1	1
Ni	WS	41	27	29.36	0.629		14-48	0.297-1.085		1	1		6.50E+00	1	1
	DS	114.8	98	109.3	2.359		79.14-176	1.758-3.52		1	1		1.88E+00	0	0
	WB	34.5	22	30.67	0.704		12.46-78	0.269-1.794		2	3		4.06E+00	1	1
	DB	120	112.6	99.81	2.188		66.26-154.8	1.369-3.461		3	3		1.14E+00	0	0
	HB	53	32	43.07	0.948		21.84-56	0.432-1.383		2	2		1.52E+01	0	0
Rb	WS	62.1	59.5	54.28	1.1196	0.662	33-71.29	0.6996-1.4214	0.4338-0.9541	1	1	1	1.54E+00	1	1
	DS	212	212	188	4.0207	2.8032	51-363.8	1.2393-8.028	0.5282-5.3318	2	2	2	-9.83E+00	0	0
	WB	56.9	62.3	59.27	1.3565	0.9095	42-110	0.9744-2.53	0.3785-2.0753	2	2	2	2.63E+00	1	1
	DB	163	161	151.6	3.2355	2.3106	62.68-259.4	1.295-5.415	1.2812-3.7519	2	2	2	-2.83E+00	0	0
	HB	157	150	152.9	3.3153	2.0544	95-210	2.0425-5.187	1.1888-3.196	2	2	3	2.73E+00	0	0

Arithmetic mean (n=11) of metal content in ashes of thin (up to 4 mm diameter) and thick twigs; metal content in twigs and crowns based on the twig, crown dry weight.
The range for metal concentrations measured in twig ashes, twigs (DW) and crowns (DW) is shown.
Seasonal category 1 indicated thst SD for multiple samplings is higher than seasonal SD; category 2 indicated that seasonal SD is higher than SD for multiple sampling, but does not exceed twice the value.
Category 3 indicates very high seasonal variations, where seasonal SD exceed more than twice the SD of multiple sampling.
The rate of phloem build-up is shown as a percentage of the crown element concentration per day.
The quality of element concentration in twig ashes and in the crown with the root water uptake is qualified as poor (0), good (1) and excellent (3).

Table 4: Group B elements in black spruce crowns in WS, DS, WB, DB and HB trees. Element content in thin and thick twigs, seasonal averages, phloem buildup values in crown (twigs) and evaluation of the correlation between the crown element content and root water uptake.

element content in twig ash				seasonal average			element content range			seasonal category			phloem build-up	correlation with the root water uptake	
		thin (ppm)	thick (ppm)	ash (twig) (ppm)	twigs (ppm/DW)	crown (ppm/DW)	ash (twig) (ppm)	twigs (ppm/DW)	crown (ppm/DW)	ash (twig)	twigs	crown	CR (TW) (%of CR conc./day)	ash	CR (TW)
Al	WS	0.27	0.18	0.207	0.0044		0.133-0.26	0.0021-0.0059		1	1		-1.66E+00	0	0
%	DS	0.35	0.32	0.31	0.0066		0.16-0.52	0.0039-0.0109		1	1		1.04E+01	0	0
	WB	0.25	0.16	0.193	0.0045		0.107-0.24	0.0023-0.0057		1	1		-2.94E+00	1	1
	DB	0.27	0.22	0.223	0.005		0.143-0.335	0.003-0.0079		2	2		5.90E+00	0	0
	HB	0.3	0.18	0.255	0.0056		0.182-0.36	0.0036-0.0077		1	1		2.10E+01	1	1
As	WS	2.6	3	2.214	0.0464	0.0193	0.12-0.337	0.025-0.070	0.0113-0.0403	1	1	2	2.12E+00	0	0
	DS	2.06	1.68	1.803	0.039	0.0167	0.65-2.8	0.013-0.059	0.006-0.025	1	1	1	1.11E+01	0	1
	WB	1.35	0.8	1.924	0.0439	0.018	0-5.3	0-0.1219	0-0.0223	2	2	2	8.60E-02	0	0
	DB	1.38	1.5	1.554	0.0343	0.0149	0.8-2.569	0.019-0.0498	0.0082-0.0221	1	1	1	7.72E-01	0	1
	HB	2.21	0.95	1.613	0.0379	0.0153	0-2.6	0-0.0642	0-0.029	2	2	2	1.01E+01	0	0
Au	WS	44.9	25.5	32.96	0.714	0.292	10-92.0	0.21-1.95	0.081-0.703	2	2	2	8.66E+00	0	1
ppb	DS	30.8	15.8	32.54	0.7092	0.318	17.75-50	0.33-1.13	0.168-0.510	2	2	2	9.19E+00	1	2
	WB	37.3	19.4	29.74	0.7	0.294	13.97-55.5	0.41-1.16	0.144-0.694	2	2	2	2.68E+00	0	1
	DB	43.2	23.5	31.39	0.689	0.311	9.85-44.61	0.204-1.108	0.116-0.556	1	1	1	1.08E+01	0	1
	HB	24.8	22.17	28.34	0.599	0.25	10.92-48	0.216-0.926	0.082-0.341	1	1	1	9.33E+00	0	1
Ba	WS	860	973	890.3	18.28	7.62	520-1190	11.02-24.86	3.76-16.79	2	2	2	-6.88E+00	0	1
	DS	1144	1416	1258	27.28	12.648	757.7-1900	16.83-46.17	6.83-17.34	1	1	1	-5.32E+00	1	0
	WB	886	992	811	18.61	8.6377	520-1250	11.554-28.11	3.86-14.41	1	1	1	-6.36E+00	0	2
	DB	1266	1265	1287	27.66	14.096	719.2-2600	13.94-54.34	7.04-29.12	2	2	2	-6.42E-01	0	2
	HB	935	968	768	16.9	7.5873	510-1100	12.42-26.4	3.68-15.47	2	2	2	-9.20E+00	0	0
Br	WS	34.7	37	33.1	0.672	0.6893	24-52	0.422-1.102	0.49-1.01	1	1	1	-8.89E+00	0	1
	DS	26.2	19.8	23.6	0.515	0.5723	12.42-36.5	0.23-0.766	0.31-0.82	1	1	1	1.20E+01	0	1
	WB	20.8	20.4	22.8	0.526	0.5411	'11-44	0.338-1.002	0.381-0.706	3	2	1	-2.01E+00	2	1
	DB	20.8	20.1	19.3	0.423	0.5246	14.91-24.5	0.303-0.576	0.387-0.813	2	2	2	-1.21E+00	1	0
	HB	19.3	19.7	22.5	0.476	0.522	16.19-29	0.324-0.683	0.326-0.738	1	1	1	-1.49E+01	0	2
Cd	WS	1.67	1.7	1.32	0.0279		0.6-1.705	0.0128-0.0509		2	1		-7.31E+00	2	0
	DS	1.88	1.6	1.53	0.0335		1.061-2.2	0.0236-0.0535		1	1		2.69E+00	0	0
	WB	1.2	0.6	1.21	0.0279		0-2.6	0-0.0567		2	2		-6.99E+00	1	0
	DB	1.08	0.92	1.47	0.0323		0-2.676	0-0.0629		2	2		3.35E-01	0	2
	HB	1.3	0.3	1.22	0.0269		0-2.2	0-0.0543		1	2		1.18E+01	0	0
Cr	WS	14.4	13.6	12.5	0.263	0.1057	8.104-16	0.124-0.338	0.079-0.225	1	1	3	2.07E-01	0	1
	DS	14.8	15	14.5	0.311	0.1284	9.0-23	0.201-0.483	0.098-0.196	1	1	1	8.96E+00	0	1
	WB	13.9	8.4	10	0.235	0.0905	6.23-15	0.134-0.345	0.0534-0.166	1	1	2	-2.04E+00	0	2
	DB	15.4	16.9	16.1	0.345	0.1448	9.15-21.41	0.206-0.435	0.112-0.181	2	2	1	6.32E-01	2	1
	HB	18.3	15	16.1	0.351	0.1433	12.59-25	0.252-0.538	0.107-0.22	1	1	1	2.69E+00	0	2

Table 4: Group B elements in black spruce crowns in WS, DS, WB, DB and HB trees. Element content in thin and thick twigs, seasonal averages, phloem buildup values in crown (twigs) and evaluation of the correlation between the crown element content and root water uptake. (continued)

element content in twig ash				seasonal average			element content range			seasonal category			phloem build-up	correlation with the root water uptake	
		thin (ppm)	thick (ppm)	ash (twig) (ppm)	twigs (ppm/DW)	crown (ppm/DW)	ash (twig) (ppm)	twigs (ppm/DW)	crown (ppm/DW)	ash (twig)	twigs	crown	CR (TW) (%of CR conc./day)	ash	CR (TW)
Cs	WS	0.63	0.29	0.534	0.0108	0.0062	0-1.05	0-0.0327	0-0.0245	1	1	1	7.62E+00	0	0
	DS	1.7	1.46	1.506	0.0324	0.0268	1.1-1.75	0.022-0.394	0.0209-0.0325	1	1	1	-1.80E+00	0	1
	WB	0.83	0.64	0.711	0.0165	0.0133	0-1.6	0-0.0368	0-0.0095	1	1	1	-2.90E+00	1	0
	DB	0.86	0.92	1.077	0.0226	0.0214	0.627-1.5	0.0123-0.0348	0.0155-0.0373	1	1	2	3.70E+00	0	0
	HB	1.17	0.97	1.084	0.0235	0.0192	0.819-1.7	0.0155-0.042	0.00541-0.012	2	2	2	1.27E+00	1	2
Hf	WS	2.16	1.82	0.526	0.0111	0.004	0-0.9	0-0.019	0-0.0056	1	1	2	1.76E+01	0	0
	DS	2.25	1.72	0.554	0.0127	0.0042	0-1.5	0-0.0315	0-0.0111	1	1	1	2.14E+01	1	1
	WB	2.37	1.91	0.377	0.0088	0.0031	0-0.9	0-0.0209	0-0.0059	1	1	2	8.06E-01	0	2
	DB	2.21	1.89	0.359	0.0076	0.0026	0-0.942	0-0.0183	0-0.0064	1	1	1	4.49E+00	0	0
	HB	2.22	1.76	0.637	0.0139	0.0048	0-1.2	0-0.0232	0-0.0078	1	1	2	1.17E+01	2	0
Na	WS	2365	2043	1841	38.76	15.1	1350-2232	28.62-47.45	9.47-33.19	1	1	3	8.15E+00	0	0
	DS	2468	2218	2189	45.83	19.05	1400-3800	31.82-79.8	12.17-31.71	1	1	1	9.98E+00	0	0
	WB	2248	1336	1579	36.9	14.023	1180-2140	26.11-49.22	10.43-23.71	1	1	1	7.31E-01	1	2
	DB	1903	1809	1815	39.96	16.114	1316-2748	24.5-58.16	9.65-21.65	2	2	2	1.40E+00	0	1
	HB	2630	1709	2236	48.72	19.311	1437-3300	28.44-70.95	12.28-28.9	1	1	2	1.17E+01	0	2
Pb	WS	11.9	7	7.87	0.17		4.86-12	0.074-0.266		1	1		5.72E+00	0	0
	DS	17.9	11.8	12.51	0.272		4.0-22	0.089-0.462		1	1		9.86E+00	0	0
	WB	12.5	6.25	10.41	0.242		6.0-14.0	0.135-0.365		1	1		-4.16E+00	0	0
	DB	10.8	7.4	8.92	0.199		3.58-13.38	0.074-0.314		1	1		1.34E+00	0	0
	HB	13	6.7	10.12	0.221		5.4-20	0.108-0.43		1	1		3.23E+01	0	0
Sb	WS	0.22	0.23	0.206	0.0042	0.00179	0.1-0.298	0.00195-0.00633	0.00084-0.00323	1	1	1	2.60E+00	0	0
	DS	0.26	0.18	0.161	0.00346	0.00151	0-0.3	0-0.0063	0-0.0027	1	1	1	3.63E+01	0	0
	WB	0.21	0.1	0.188	0.00451	0.00186	0-0.3	0-0.00714	0-0.00352	2	2	2	-1.34E+00	0	2
	DB	0.2	0.17	0.163	0.0036	0.00161	0-0.25	0-0.00563	0-0.00321	1	1	1	4.16E+00	2	2
	HB	0.23	0.15	0.22	0.00481	0.00206	0.091-0.4	0.0018-0.00772	0.00075-0.00316	2	2	2	3.03E+00	0	0
Sc	WS	1.29	1.05	1.055	0.0223	0.0086	0.805-1.21	0.0149-0.0271	0.006-0.0191	1	1	3	5.40E+00	0	0
	DS	1.24	1.12	1.138	0.0244	0.0096	0.7-2.1	0.0156-0.0441	0.007-0.0174	1	1	1	1.15E+01	0	0
	WB	1.37	0.9	0.825	0.0191	0.0072	0.5-1	0.0134-0.0238	0.0053-0.0109	1	1	1	-7.44E-01	0	2
	DB	0.98	0.9	0.911	0.0201	0.008	0.582-1.284	0.0136-0.0288	0.0055-0.0106	2	2	2	2.21E+00	0	2
	HB	1.1	0.7	1.138	0.0249	0.0096	0.728-1.7	0.0144-0.0366	0.0054-0.0146	1	1	1	9.63E+00	0	1
Sr	WS	935	845	812	17.3	7.8441	0-1185	0-26.78	0-12.77	2	2	2	-6.96E+00	0	0
	DS	530	432	552	12.38	6.7845	0-1155	0-25.34	0-14.60	3	2	2	-1.24E+01	0	0
	WB	1087	1080	819	19.61	11.325	0-1400	0-42.56	0-31.731	3	2	2	-4.05E+00	1	1
	DB	676	629	628	13.21	8.4066	0-880	0-22.79	0-9.93	3	3	2	-6.47E-01	1	1
	HB	1268	1117	1130	24.24	12.451	846.1-1550	16.74-35.64	4.74-18.30	2	2	2	-1.46E+01	0	1

Table 4: Group B elements in black spruce crowns in WS, DS, WB, DB and HB trees. Element content in thin and thick twigs, seasonal averages, phloem buildup values in crown (twigs) and evaluation of the correlation between the crown element content and root water uptake. (continued)

element content in twig ash				seasonal average			element content range			seasonal category			phloem build-up	correlation with the root water uptake	
		thin (ppm)	thick (ppm)	ash (twig) (ppm)	twigs (ppm/DW)	crown (ppm/DW)	ash (twig) (ppm)	twigs (ppm/DW)	crown (ppm/DW)	ash (twig)	twigs	crown	CR (TW) (%of CR conc./day)	ash	CR (TW)
Th	WS	1.15	0.59	0.796	0.0176	0.0084	0.3-1.15	0.0097-0.0249	0.0022-0.0173	1	1	1	6.41E+00	0	0
	DS	1.24	0.8	0.989	0.0212	0.0083	0.7-1.6	0.0156-0.0336	0.0056-0.0143	1	1	1	1.96E+01	0	0
	WB	1.08	0.51	0.666	0.0157	0.0056	0-1.0	0-0.021	0-0.0072	1	2	1	-1.08E+00	0	0
	DB	0.83	0.8	0.861	0.0187	0.0073	0.58-1.37	0.011-0.0288	0.0052-0.0109	2	2	2	2.35E+00	0	0
	HB	1.2	0.8	1.067	0.0231	0.0088	0.819-1.4	0.0162-0.0342	0.0056-0.0136	1	1	2	1.36E+01	2	2
V	WS	6.25	4.25	4.9	0.105		3.241-6	0.050-0.1356		2	1		-3.00E+00	0	0
	DS	5.75	3.25	5.52	0.118		2-12.0	0.045-0.252		1	1		1.63E+01	0	0
	WB	5.75	3.25	4.21	0.097		1.78-6.0	0.038-0.143		1	1		-3.43E+00	1	1
	DB	4.8	4	4.06	0.09		3.31-6.69	0.074-0.157		2	2		7.00E+00	0	0
	HB	7	4.3	5.95	0.131		3.64-8.0	0.072-0.198		1	1		2.14E+01	1	1
W	WS	37.9	28	30.9	0.649		0-40.0	0-0.904		2	2		2.26E+00	0	0
	DS	36	24.4	25.8	0.567		10-40.0	0.232-0.972		2	2		6.95E+00	2	2
	WB	40	32	29.7	0.69		0-40.0	0-0.89		3	2		1.31E+00	0	0
	DB	38	8.4	28	0.61		16.6-44.6	0.37-1.048		2	2		4.67E-01	2	2
	HB	40	33.5	35	0.8		18.2-60.0	0.36-1.48		3	3		6.30E-01	0	0

Arithmetic mean (n=11) of metal content in ashes of thin (up to 4 mm diameter) and thick twigs; metal content in twigs and crowns based on the twig, crown dry weight.
The range for metal concentrations measured in twig ashes, twigs (DW) and crowns (DW) is shown.
Seasonal category 1 indicated that SD for multiple samplings is higher than seasonal SD; category 2 indicated that seasonal SD is higher than SD for multiple sampling, but does not exceed twice the value.
Category 3 indicates very high seasonal variations, where seasonal SD exceed more than twice the SD of multiple sampling.
The rate of phloem build-up is shown as a percentage of the crown element concentration per day.
The quality of element concentration in twig ashes and in the crown with the root water uptake is qualified as poor (0), good (1) and excellent (3).

Table 5: Group C elements in black spruce crowns in WS, DS, WB, DB and HB trees. Element content in thin and thick twigs, seasonal averages, phloem buildup values in crown (twigs) and evaluation of the correlation between the crown element content and root water uptake.

		element content in twig ash			seasonal average		element content range			seasonal category			phloem build-up	correlation with the root water uptake	
		thin (ppm)	thick (ppm)	ash (twig) (ppm)	twigs (ppm/DW)	crown (ppm/DW)	ash (twig) (ppm)	twigs (ppm/DW)	crown (ppm/DW)	ash	twigs	crown	crown or twig (%of CR conc./day)	ash	crown
Ce	WS	8.75	3.9	5.87	0.1297	0.0482	0-9	0-0.203	0-0.659	2	2	3	3.84E+00	0	1
	DS	9.4	8	8.21	0.1769	0.0689	5.324-15	0.098-0.315	0.0423-0.121	1	1	1	1.41E+01	0	0
	WB	8.4	2.4	5.33	0.1267	0.0456	0-7.5	0-0.167	0-0.0759	1	1	1	1.04E+00	0	2
	DB	6.8	6.2	6.30	0.139	0.0541	3.744-9.418	0.095-0.202	0.0295-0.0526	3	2	2	2.58E+00	0	0
	HB	9.2	4.7	7.38	0.1613	0.0618	5.46-10	0.108-0.215	0.0355-0.0958	1	1	2	2.09E+01	0	2
La	WS	4.81	3.3	3.57	0.0764	0.0285	2.674-4.5	0.041-0.087	0.0189-0.0284	1	1	3	6.11E+00	0	1
	DS	4.96	3.76	4.30	0.0922	0.00363	2.6-8.1	0.058-0.171	0.0219-0.0655	1	1	1	1.33E+02	0	0
	WB	4.3	2.5	3.11	0.072	0.0265	2.046-3.5	0.044-0.093	0.0172-0.0403	1	1	1	-1.80E-02	1	1
	DB	3.71	3	3.20	0.071	0.0273	1.75-4.8	0.043-0.099	0.0167-0.0376	3	2	2	2.35E+00	0	0
	HB	5.25	2.98	4.20	0.0916	0.0351	2.46-5.8	0.049-0.125	0.0167-0.0495	1	1	1	1.29E+01	0	1
Sm	WS	0.56	0.39	0.43	0.0092	0.00341	0.322-0.55	0.0076-0.0116	0.00231-0.00789	1	1	2	5.05E+00	0	1
	DS	0.6	0.46	0.50	0.0108	0.00427	0.3-1	0.0066-0.0115	0.00248-0.00811	1	1	1	1.44E+01	0	0
	WB	0.53	0.29	0.38	0.0089	0.00326	0.267-0.5	0.0058-0.012	0.00224-0.00481	1	1	1	-2.41E-01	0	2
	DB	0.41	0.36	0.38	0.0085	0.00327	0.25-0.558	0.0052-0.013	0.00199-0.00472	2	2	2	2.26E+00	0	1
	HB	0.62	0.35	0.51	0.011	0.00418	0.273-0.8	0.0054-0.0172	0.0019-0.00679	1	1	2	1.41E+01	0	2
Yb	WS	0.22	0.12	0.13	0.0029	0.0012	0-0.27	0-0.0054	0-0.0041	2	2	3	1.86E+01	0	2
	DS	0.29	0.18	0.26	0.0058	0.0023	0-0.43	0-0.009	0-0.0037	1	1	1	1.62E+01	0	1
	WB	0.23	0.13	0.18	0.0041	0.0017	0-0.32	0-0.0063	0-0.0028	1	1	1	-4.97E+00	0	2
	DB	0.19	0.17	0.16	0.0036	0.0015	0-0.25	0-0.059	0-0.0026	2	2	2	7.78E-01	0	0
	HB	0.29	0.08	0.16	0.0038	0.0016	0-0.34	0-0.0084	0-0.0036	1	1	1	2.73E+01	1	2

Arithmetic mean (n=11) of metal content in ashes of thin (up to 4 mm diameter) and thick twigs; metal content in twigs and crowns based on the twig, crown dry weight.
The range for metal concentrations measured in twig ashes, twigs (DW) and crowns (DW) is shown.
Seasonal category 1 indicated that SD for multiple samplings is higher than seasonal SD; category 2 indicated that seasonal SD is higher than SD for multiple sampling, but does not exceed twice the value.
Category 3 indicates very high seasonal variations, where seasonal SD exceed more than twice the SD of multiple sampling.
The rate of phloem build-up is shown as a percentage of the crown element concentration per day.
The quality of element concentration in twig ashes and in the crown with the root water uptake is qualified as poor (0), good (1) and excellent (3).

Table 6: Group A elements in black spruce outer bark.

		ASH %	Ca %	K %	Fe %	Mg %	P ppm	Mn ppm	Zn ppm	Cu ppm
WS	arithmetic mean	4.23	17.32	2.6	1.38	0.86	4423	1620	1260	56.7
	SD	0.66	2.914	0.29	0.13	0.1	644	344.3	438	6.28
	median	4.435	15.85	2.6	1.41	0.88	4320	1680	1150	57
DS	arithmetic mean	7.162	17.58	2.47	1.6	0.71	2824	2242	762	45.2
	SD	1.079	3.834	0.26	0.25	0.08	216	646.2	242	6.1
	median	7.441	17.69	2.53	1.62	0.71	2827	2316	756	44.6
WB	arithmetic mean	5.19	18.8	2.39	1.33	0.84	3514	1538	1038	46.4
	SD	0.811	2.404	0.25	0.19	0.15	646	419.5	265	6.54
	median	5.11	18.9	2.42	1.28	0.78	3120	1640	960	44
DB	arithmetic mean	6.153	19.03	2.45	1.38	0.74	2461	1766	745	43.4
	SD	0.992	2.581	0.49	0.17	0.07	337	626.8	115	6.31
	median	6.385	17.85	2.54	1.47	0.73	2430	1725	710	43
HB	arithmetic mean	8.194	13.4	2.92	1.71	1.06	1990	1350	808	34.4
	SD	0.881	1.987	0.59	0.23	0.25	500	283.5	231	7.8
	median	8.11	12.7	3.05	1.77	0.94	1990	1250	730	34

Essential elements (group A) in bark ashes (n=5)

Table 7: Group B elements in black spruce outer bark.

		ASH %	Ag ppm	Co ppm	Cs ppm	Ni ppm	Rb ppm
WS	arithmetic mean	4.23	5.27	0.516	0.18	5.76	13.9
	SD	0.66	0.4	8	1.45	52	53
	median	4.44	0	10.6	1.54	52.4	62.6
DS	arithmetic mean	7.16	0	0.894	0.36	6.07	14.5
	SD	1.08	0	10	1.5	56	69
	median	7.44	0.4	8.4	1.34	44	50.6
WB	arithmetic mean	5.19	5.27	0.548	0.36	8.72	11.5
	SD	0.81	0.4	8	1.4	46	48
	median	5.11	0.333	9.333	1.3	48	57.5
DB	arithmetic mean	6.15	0.163	0.516	0.33	9.12	10.3
	SD	0.99	0.4	9	1.3	45	57
	median	6.39	0.08	9.2	1.3	42.8	68.2
HB	arithmetic mean	8.19	0.179	1.095	1.03	7.16	11.3
	SD	0.88	0	10	1.6	42	68
	median						

Nonessential elements (group B) in bark ashes (n=5)

most affected by the soil drainage were: Mn (5158, 11043 ppm in ash in W and D trees, respectively), Cu (148, 203 ppm in ash in W and D trees, respectively), Ag (0.8, 1.34 ppm in ash in W and D trees, respectively), Co (4.05,14.4 ppm in ash in W and D trees, respectively), Ni (29.9, 105 ppm in ash in W and D trees, respectively) and Rb (56.8,169.8 ppm in ash in W and D trees, respectively). These elements are pH sensitive. Differences between element content in thin and thick crown twigs also display the effects of site drainage (Table 4, 5). Seasonal changes were highest for essential elements and pH sensitive elements depending on the experimental group (Table 2, 3), including Au (range 9.85-92.0 ppb in ash), Sr (0-1550 ppm in ash) and W (0-60 ppm in ash, Table 4). A steady increase or decrease in metal twig concentration during the two month measuring season was not observed.

Essential elements: group A

Nine essential elements were analyzed in twig ashes of black spruce crowns and outer bark (Ca, K, Fe, Mg, P, Mn, Zn, Cu and Mo). The Mo concentrations in twigs and outer bark were below the detection limit and are not shown.

Essential elements are necessary for plant metabolism. These elements are generally not expected to be enriched in extremities (outer bark) due to physiological functions. The essential elements would be elevated in crown organs or lower branches. This assumption was found correct for most of the essential elements in that twig element concentration of essential elements exceeded the bark concentration by factors of two to eight (Table 9). Similar values of twig and bark metal concentration were found for Ca and P; Fe was more concentrated in bark than in twigs.

Manganese and Cu were the only essential elements with a significant difference between experimental groups. Trees growing on dry sites accumulated approximately 100% more Mn and 25-50% more Cu compared to trees growing on wet or moderately drained sites (Tables 2, 9, Appendix 1). This difference was partly reflected by similar concentration differences in bark ashes for Mn; no difference was found in bark ashes for Cu (Table 9). Similar concentrations of Zn and P are present in crown twigs in all groups. Elevated Zn and P concentrations in bark was documented from trees growing on wet sites as compared to trees growing on dry or moderately drained sites (Tables 6, 9).

Ca

A good correlation between root water uptake

Table 8: Group B, C, and D elements in black spruce outer bark.

		ASH %	Al %	Au ppb	Au ppm	Ba ppm	Br ppm	Cd ppm	Ce ppm	Cr ppm	Cs ppm	Eu ppm	Hf ppm	La ppm	Lu ppm	Na ppm	Nd ppm	Pb ppm
WS	arithmetic mean	4.23	0.81	21.67	4.5	2183	27.5	3.46	38	36.33	1.417	0.593	3.817	21.67	0.155	10193	18	110.4
	SD	0.66	0.082	8.091	1.226	966.3	10.11	0.96	4.1	4.274	0.183	0.113	0.458	2.503	0.028	1675	3.633	10.14
	median	4.435	0.81	18.5	4.35	2050	29.5	3.3	38.5	36.5	12.95	0.625	3.8	22.5	0.16	10545	19	114
DS	arithmetic mean	7.162	0.968	1.6	2.84	1680	40.2	2.72	46.8	42.4	1.54	0.642	3.98	27.6	0.168	11326	21.4	145.6
	SD	1.079	0.103	3.578	0.723	249	12.17	0.63	8.23	6.427	0.365	0.125	0.576	5.03	0.029	2331	4.159	29.98
	median	7.441	0.98	0	2.8	1600	33	2.6	48	43	23.68	0.7	4.2	29	0.17	11500	23	156
WB	arithmetic mean	5.19	0.832	12.6	3.58	1840	35.6	2.4	37.4	36.8	1.34	0.572	3.68	21	0.142	10026	17.2	101.2
	SD	0.811	0.124	8.62	0.705	493	7.232	0.79	5.73	4.147	0.358	0.061	0.349	3.24	0.019	1948	2.28	9.338
	median	5.11	0.84	68.41	19.69	26.79	20.31	32.8	15.3	11.27	26.7	10.66	9.491	15.43	13.55	19.43	13.26	9.227
DB	arithmetic mean	6.153	0.9	8.333	2.6	1257	33.67	1.74	38.5	40.67	1.3	0.558	3.5	21.83	0.125	10483	17	104
	SD	0.992	0.113	5.574	0.447	345.6	8.165	0.31	6.66	4.457	0.335	0.062	0.374	2.787	0.03	1359	2.28	13.34
	median	6.385	0.87	8	2.6	1245	35	1.8	37	40.5	25.74	0.55	3.65	22.5	0.125	10800	17	101
HB	arithmetic mean	8.194	1.064	11.2	2.9	916	17.6	1.2	50.8	45.2	1.3	0.68	4.42	29.8	0.136	15580	19.8	135.6
	SD	0.881	0.18	6.686	1.102	68.77	5.814	1.26	6.42	4.604	1.032	0.096	0.54	3.633	0.026	1699	1.789	29.44
	median	8.11	1.12	15	2.6	930	16	1.6	53	46	79.38	0.75	4.6	31	0.14	16500	20	134

		Sb ppm	Sc ppm	Sm ppm	Sr ppm	Ti %	Th ppm	U ppm	V ppm	Yb ppm	Y ppm	Zr ppm
WS	arithmetic mean	0.917	3.833333	2.2	677	0.05	5.7	1.13	20.2	0.862	4.8	10.2
	SD	0.117	0.40332	0.21	227	0.01	0.94	0.24	1.48	0.095	1.095	1.483
	median	0.8	3.9	2.25	629	0.05	5.7	1.1	20	0.89	5	10
DS	arithmetic mean	0.88	4.18	2.6	296	0.068	7.8	1.32	22.8	0.93	5.6	12.4
	SD	0.217	0.657267	0.412	24.8	0.011	1.51	0.36	3.03	0.135	0.894	2.191
	median	0.9	4.2	2.7	308	0.06	7.7	1.4	24	0.93	6	12
WB	arithmetic mean	0.76	3.72	2.08	571	0.048	5.8	1.22	19.6	0.776	4.4	8.8
	SD	0.195	0.56745	0.286	219	0.011	1.21	0.2	2.61	0.08	0.894	2.28
	median	25.65	15.25404	13.77	38.4	22.82	20.9	16.8	13.3	10.33	20.33	25.91
DB	arithmetic mean	0.667	3.65	2.067	362	0.058	6.52	1.13	20.6	0.758	4.4	11.6
	SD	0.103	0.550454	0.301	101	0.004	0.95	0.19	2.97	0.104	0.894	1.673
	median	0.7	3.55	2.15	296	0.06	6.65	1.15	20	0.785	4	11
HB	arithmetic mean	0.56	4.28	2.56	391	0.096	9.88	1.7	23.6	0.772	4.4	16.4
	SD	0.134	0.589067	0.288	114	0.017	1.19	0.25	4.34	0.138	0.894	2.191
	median	0.5	4.6	2.7	356	0.1	10	1.8	26	0.74	4	18

Elements (group B, C and D) in bark ashes (n=5)

Table 9: Seasonal average of essential elements in group A twig ashes (TW) and average element concentration in outer bark (OB).

	Ca %	K %	Fe %	Mg %	P ppm	Mn ppm	Zn ppm	Cu ppm
WS-TW	17.32	19.23	0.36	5.33	38021	4785	2056	137.6
WS-OB	17.32	2.60	1.38	0.86	4423	1620	1260	56.67
DS-TW	16.39	19.34	0.40	4.28	37418	10712	1734	211
DS-OB	17.58	2.47	1.60	0.71	2824	2242	762	45.2
WB-TW	17.94	18.16	0.29	5.0	35799	5531	1795	154
WB-OB	18.8	2.39	1.33	0.84	3514	1538	1038	46.4
DB-TW	17.75	16.89	0.33	4.59	33374	11373	1610	191.3
DB-OB	19.03	2.45	1.38	0.74	2461	1766	745	43.4
HB-TW	16.64	18.5	0.39	5.27	34334	5029	1859	123.8
HB-OB	13.4	2.92	1.71	1.06	1990	1350	808	34.4

and Ca crown content was obtained for trees growing on well or partially drained sites (WS, WB and HB, Appendix 2). However, the seasonal SD did not substantially exceed the average SD of multiple samplings indicating that seasonal changes are of a similar magnitude to differences caused by variability in the plant material combined with the analytical error (Appendix 1). Phloem buildup was uniformly negative for all experimental groups. Higher Ca concentration in thick twigs compared to thin twigs suggests that Ca is being concentrated in the central woody part of the twig compared to the bark, confirming similar published findings (Dunn, 1981, 1992). Low phloem buildup values are indicative of high Ca redistribution from the crown, possibly to the woody parts of the tree. This is attributed to the role of Ca as a major component of the cells that comprise the wood tissue. No differences in Ca twig concentration were found in trees of different experimental groups. The concentration of Ca in bark and twigs was similar with the exception of HB trees (Table 9). Bark of HB trees had a lower Ca concentration compared to trees of the WB and DB group.

K

Potassium is the most abundant element in plant tissues, the major cation forming the osmotic balance.

Table 10: Seasonal average of pH sensitive elements in group B twig ashes (TW) and average element concentration in outer bark (OB), well drained sites. Nd=not detected.

	Ag ppm	Co ppm	Ni ppm	Rb ppm
WS-TW	0.76	4.28	29.4	54.3
WS-OB	0.40	7.67	50.2	51.3
DS-TW	1.28	13.7	109.3	188
DS-OB	nd	10.6	52.4	62.6
WB-TW	0.84	3.83	30.7	59.3
WB-OB	0.40	8.40	44.0	50.6
DB-TW	1.40	10.8	99.8	152
DB-OB	0.33	9.33	48.0	57.5
HB-TW	0.71	3.91	43.1	153
HB-OB	0.08	9.2	42.8	68.2

Table 11: Seasonal average of elements in group B twig ashes (TW) and average element concentration in outer bark (OB). Non-essential elements in crown twigs of group B, variable drainage. Nd=not detected.

	Al %	As ppm	Au ppb	Ba ppm	Br ppm	Cd ppm	Cr ppm	Cs ppm	Hf ppm	Na ppm	Pb ppm	Sb ppm	Sc ppm	Sr ppm	Th ppm	V ppm	W ppm
WS-TW	0.21	2.21	33.0	890	33.1	1.32	12.5	0.53	0.53	1841	7.87	0.21	1.06	812	0.80	4.90	30.9
WS-OB	0.81	4.50	21.7	2183	27.5	3.46	36.3	1.42	3.82	10193	110	0.92	3.80	677	5.70	20.2	nd
DS-TW	0.31	1.80	32.5	1258	23.6	1.53	14.5	1.51	0.55	2189	12.5	0.16	1.14	552	0.99	5.52	25.8
DS-OB	0.97	2.84	1.60	1680	40.2	2.72	42.4	1.54	3.98	11326	146	0.88	4.20	296	7.80	22.8	nd
WB-TW	0.19	1.92	29.7	811	22.8	1.21	10.0	0.71	0.38	1579	10.4	0.19	0.83	819	0.67	4.21	29.7
WB-OB	0.83	3.58	12.6	1840	35.6	2.40	36.8	1.34	3.68	10026	101	0.76	3.70	571	5.80	19.6	nd
DB-TW	0.22	1.55	31.4	1287	19.3	1.47	16.1	1.08	0.36	1815	8.92	0.16	0.91	628	0.86	4.06	28.0
DB-OB	0.90	2.60	8.33	1257	33.7	1.74	40.7	1.30	3.50	10483	104	0.67	3.70	362	6.52	20.6	nd
HB-TW	0.26	1.61	28.3	768	22.5	1.22	16.1	1.08	0.64	2236	10.1	0.22	1.14	1130	1.07	5.95	35.0
HB-OB	1.06	2.90	11.2	916	17.6	1.20	45.2	1.30	4.42	15580	136	0.56	4.30	391	9.88	23.6	nd

Table 12: Seasonal average of rare-earth elements (REEs) in group C twig ashes and average element concentration in outer bark (OB).

	Ce ppm	La ppm	Sm ppm	Yb ppm
WS-TW	5.87	3.57	0.43	0.13
WS-OB	38.0	21.7	2.20	0.86
DS-TW	8.21	4.30	0.50	0.26
DS-OB	46.8	27.6	2.60	0.93
WB-TW	5.33	3.11	0.38	0.18
WB-OB	37.4	21.0	2.10	0.78
DB-TW	6.30	3.20	0.38	0.16
DB-OB	38.5	21.8	2.10	0.76
HB-TW	7.38	4.20	0.51	0.16
HB-OB	50.8	29.8	2.6	0.77

There is twice as much K present in needles, compared to twigs according to published data (Fedikow and Dunn, 1996). No significant differences in trees of the various test groups were found in any of the crown organs and outer bark. Thin and thick twigs contained K in similar concentrations in all groups (Table 2). Twig ashes contain approximately 8 times less K compared to twigs and this is attributed to the role of K as a osmoticum in living tree organs. Good correlation exists between root water uptake and K crown concentration in DS and HB trees (Appendix 2). The seasonal changes exceed the average SD measured within multiple samplings in most experimental groups (Appendix 1).

Mg

Magnesium is an important element involved in many metabolic and plasma membrane transport processes. Magnesium is also a part of chlorophyll molecule thereby providing an explanation for the relatively high Mg concentrations in living plant tissues. No significant differences in Mg content was observed between different experimental groups including crown organs

and outer bark concentrations. Twig Mg contents are greater than 6.5 times that of bark, reflecting the metabolic role of Mg in living tissues. Relatively high phloem buildup values coinciding with low Mg bark concentration (Table 2, 9) suggest substantial Mg redistribution to the main tree branches. Good correlation between root water uptake and Mg twig concentration was found in trees of the HB, DS and WS groups. Changes in Mg twig content with root water uptake were negligible in trees of DB and WB groups (Appendix 2).

Fe

Iron plays an important role in respiratory and secondary metabolism enhanced during plant growth. Nevertheless, no significant increase in twig Fe content was detected during the measurement period (Appendix 9). The standard deviation was lower for the crown Fe content compared to the twig ash Fe content in four out of five experimental groups indicating high Fe redistribution within the crown during the survey (Appendix 1). Iron concentration in thin twigs was higher than in thick twigs in trees growing on poorly drained sites (Table 2). Iron is approximately three times more abundant in bark than in twigs; no differences between experimental groups were observed (Table 9). A good correlation between root water uptake and Fe crown content was found in trees with higher numbers of transpiring branches (WB, DB and HB) and thus higher water flux values (Table 2, Appendix 2).

Mn

Significantly higher concentrations of manganese were found in crown twigs from trees growing on well drained sites (DS = 10 712 ppm in ash, DB = 11 373 ppm in ash) compared to those of trees growing on wet sites (WS = 4 785 ppm in ash, WB = 5 531 ppm in ash). Approximately twice as much Mn was measured in crown twigs in DS and DB trees compared to WS, WB and HB trees, respectively (Table 2, Appendix 2). Manganese is a pH sensitive element that is mobilized during rainy periods from the soil surface and as a result of ponded drainage is made accessible to tree roots. On poorly drained sites this does not occur and as a result roots of trees growing on these sites are not exposed to higher metal concentrations. Changes in Mn twig content correlate with root water uptake in DB, DS (except one measurement) and HB trees (Appendix 2). The seasonal SD was higher than SD of multiple sampling in all experimental groups indicating that this might be a concern when samples are collected during periods characterized by substantially different weather conditions (Appendix 1). Higher concentrations of Mn were found in the bark of DS and DB trees, similarly to that observed in twigs, but this difference was less pronounced than in twigs (Table 2, 6, 9). Generally, there was about 4-7 times less Mn in outer bark compared to twig Mn content (Table 9).

P

Phosphorus is an important element involved in all metabolic processes in living plant tissues. The highest concentration is usually found in needles. Phosphorus concentrations in thin twigs was higher than in thick twigs in all experimental groups. Higher P content was documented in bark of WS and WB trees (Table 6). P concentration in bark is comparable with P concentration in crown twigs (Table 9). Higher P bark concentration was measured in trees growing on wet sites compared to trees growing on well drained sites within groups with similar root water uptake (WS - DS, WB - DB). A good correlation between twig P content and the root water uptake was found in trees growing on well drained sites (Table 2, Appendix 2). The magnitude of changes in P twig content with water uptake was very small in WB trees.

Zn

Zinc is an important element involved in plant carbohydrate and protein metabolism. No significant differences between Zn concentrations in thin or thick twigs, and crowns from trees of different experimental groups were observed (Table 2). In trees growing on wet sites significantly higher Zn content in bark was measured (WS = 1260 ppm, WB = 1038 ppm) compared to trees growing on dry or semiwet sites (DS = 762 ppm, DB = 745 ppm, HB = 808 ppm). These differences were not found in twigs of trees of corresponding groups. There was about twice as much Zn found in twigs compared to outer bark (Table 9). The Zn content in crowns correlates with root water uptake in trees growing on dry sites (Table 2, Appendix 2). Higher values of the seasonal SD compared to the SD calculated for multiple samplings indicate the potential need for an evaluation of seasonal weather effects when black spruce crowns are sampled (Appendix 1).

Cu

Copper is largely involved in respiratory and protein metabolism and essential to some photosynthetic processes. It is the second essential element identified that exhibits significant differences between the twigs from trees in different experimental groups. There was approximately 25-50% more Cu in crown twigs of trees growing on dry sites compared to trees growing on wet sites (Table 2). Copper as well as Mn is a pH sensitive element. Differences in element concentrations in twigs relating to site drainage characteristics were not observed in outer bark, probably due to relatively small Cu bark concentration (60-80 times lower compared to twig Cu concentration, Table 9). A good correlation between Cu twig content and the root water uptake was detected in trees with a higher number of branches and larger transpiration area (WB, DB and HB trees, Table 2, Appendix 2). Seasonal changes in Cu twig content exceeded differences obtained in multiple sampling suggesting some consideration of weather conditions might be prudent during geochemical surveys of this type (Appendix 1).

Nonessential elements: group B

Enriched elements — well drained sites

Four elements (Ag, Co, Ni and Rb) are enriched in

twigs from trees growing on well drained sites compared to those growing on poorly drained sites (Table 3, Appendix 3). These elements are pH sensitive and may be concentrated in water saturated layers with better root-soil contact subsequent to mobilization by rain water. The seasonal variation in crown and twig concentration of these elements is relatively high (Appendix 3). The correlation of the root water uptake with the twig or crown element concentration in trees growing on well drained sites is poor compared to trees growing on poorly drained sites (Table 3, Appendix 4). All four elements were found in higher concentrations in crown twigs compared to outer bark in trees growing on well drained sites (Table 10).

Ag

Silver concentrations were approximately 80% higher in crown twigs from trees in the DS and DB groups compared to those from the WS, WB and HB groups (Table 3, 10). Silver is present in higher concentrations in thick compared to thin twigs (Table 3), reflecting high Ag accumulations reported for the woody part of twigs (Dunn, 1981). Similarly to Ca, negative phloem buildup values (Table 2, 3) indicate high redistribution from the crown, again, most probably to the trunk wood. A better correlation of Ag crown content (compared with the twig ash content) with the root water uptake (Table 3, Appendix 4) is the result of relatively high Ag concentrations in cones (Fedikow and Dunn, 1996). Silver concentrations in crowns correlates with root water uptake in trees of all experimental groups. Silver concentration in twigs is > twice as high as in outer bark (close to the detection limit), and as a result, observed differences are subject to large experimental error (Table 7, 10).

Co

Approximately three times more Co was measured in twigs of trees growing on well drained sites (DS = 1.28, DB = 1.40 ppm) compared to those from trees growing on poorly drained sites (WS = 0.76, WB = 0.84, HB = 0.71 ppm). Differences are not attributable to root water flux. Cobalt contents between thin and thick twigs are similar (Table 3). A good correlation between Co contents in crowns and root water uptake was documented for trees of WS, WB and HB groups (Table 3, Appendix 4). Seasonal changes were the highest for DB trees (Table 3, Appendix 3). Cobalt is commonly associated with Ni and platinum-group metals (PGM) and as such a careful evaluation of the geological characteristics of the sampling site should be done. Weather or seasonal changes in Co concentrations in bark are not anticipated since outer scaly bark is dead tissue. Accordingly, bark probably represents the preferred medium for biogeochemical surveys where Co is the element of major interest or as an indicator or pathfinder for platinum-group metals (Dunn et al., 1989).

Ni

Nickel was present in approximately 300% higher concentrations in crown twigs from trees growing on well drained sites (DS = 109.3, DB = 99.8) compared to trees growing on poorly drained or semi-wet sites (WS = 29.4 ppm, WB = 30.7 ppm, HB = 43.1 ppm). There was little difference in Ni content in thin and thick twigs from these trees (10-20%), about 80% higher Ni concentration occurs in thin twigs compared to thick twigs in trees growing on poorly drained or semi-wet sites (Table 3). This indicates higher relative Ni concentration in the woody part of twigs in DS and DB trees compared to WS, WB and HB trees. For the DS and DB trees low phloem buildup values were measured (Table 3) indicating higher Ni redistribution from the crown twigs. One might speculate on Ni "saturation" in twig bark possibly causing higher Ni concentration in the woody part (assuming relatively low Ni concentration in needles reported (cf. Fedikow and Dunn, 1996). The correlation between Ni content in twigs and root water uptake was poor for trees from the DS and DB groups in contrast to WS, WB and HB trees (Table 3, Appendix 4). Nickel concentration in the outer bark was similar to the twig Ni concentration in WS, WB and HB trees and no differences in bark Ni concentrations were detected between experimental groups (Table 10). The seasonal SD was higher than the average SD for multiple samplings in trees with high water flux (WB, DB and HB, Table 3, Appendix 3).

Rb

Approximately 300% more Rb was measured in crowns of trees growing on well drained and partially drained sites (DS = 188 ppm, DB = 152 ppm, HB = 153 ppm) compared to trees growing on poorly drained sites (WS = 54.3 ppm, WB = 59,3 ppm). These differences were not reflected in Rb contents of outer bark, that was of similar value as the Rb concentration in twigs from WB and WS trees (Table 10). There was no difference in Rb concentration in thin and thick twigs (Table 3). Low values for phloem buildup were measured in trees growing on well drained sites. For these trees, a poor correlation between root water uptake and Rb crown concentration was observed (Table 3, Appendix 4).

Elements with unchanged concentrations — well and poorly drained sites

For most of the elements of this group, higher concentrations were documented in outer bark compared to crown twigs (Table 11). The exception is Au, W and Sr. The bark and twig concentrations of Ba, Br, Cd and Cs were comparable.

Al

Approximately 80% more Al was measured in thin twigs compared to thick twigs from trees growing on wet or semi-wet sites (Table 4). For these trees a small phloem buildup was also measured, similar to that observed for Ni. The seasonal changes were comparable to differences in Al concentration in twigs measured for multiple samplings for most experimental groups. Good correlations between Al content of twig and the root water content was found for trees of WB and HB group (Table 4, Appendix 6). No differences were identified in the outer

bark concentrations of Al between different experimental groups (Table 8). Aluminum concentration in outer bark was similar to the Al concentration in twigs (Table 11). Aluminum concentrations must be viewed with caution, however, as the twigs and bark samples were ashed in aluminum trays some contamination is possible.

As

Arsenic, sometimes considered an essential element (utilized for carbohydrate metabolism), was found in higher concentrations in the outer bark (average = 3.3 ppm) as compared to twigs (1.8 ppm). Arsenic concentrations in twigs were close to the detection limit and the differences in the As content between thin and thick twigs is not significant. Relatively high phloem buildup values were measured for trees of all experimental groups (Table 4). A good correlation of As content in crowns with the root water uptake was obtained for trees of the DS and DB groups (Table 4, Appendix 6). High SD values for multiple sampling indicate that seasonal changes might be negligible (Appendix 5). For higher As concentrations in soils (resulting possibly in higher As twig concentrations) the seasonal changes may be significant.

Au

Dunn and Scagel (1989) report the highest Au contents in black spruce twigs in the early spring. This observation could not be confirmed by results of this study, based on June and July measurements. There were no patterns other than a relatively good correlation between Au crown content and the root water uptake for all experimental groups (Table 4, Appendix 6). Similarly, a correlation was not observed for Au concentrations in twigs, indicating the importance of the crown morphology. This correlation might explain the good soil to plant correlation reported for Au (Dunn, 1992). The seasonal variations in Au concentrations in crowns are relatively high (lowest for DB = 9.9-44.6 ppb, highest for WS = 10-92 ppb, Table 4, Appendix 5) and correction for weather conditions (causing differences in water flux) should prove useful. Very high Au phloem buildup values suggest low redistribution of Au to other organs of the tree. Because approximately 100% more Au was found in thin (average 39.1 ppb in ash) twigs (with larger portions of bark) compared to thick twigs (21.1 ppb in ash), except for HB trees (Table 4), twig bark might be considered as the principal Au accumulation tissue. Additionally, crowns should be carefully evaluated according to the proportion of thick and thin twigs and values normalized with respect to the thin/thick twig ratio. Differences in twig Au content in trees of different experimental groups were not observed. However, more Au was measured in the outer bark of trees growing on poorly drained sites (Table 8). Gold contents in twigs approximated 30 ppb. This is more than three times background values reported for many plants in North America (Dunn, 1992).

Ba

A relatively high SD for multiple samplings was determined for Ba contents in twigs and crowns, making the differences between experimental groups and seasonal changes in the DS and WB groups insignificant (Appendix 6). Good correlation between Ba crown content and the root water uptake was determined for trees of the WS, WB and DB groups (Appendix 6). Lower Ba concentrations in the outer bark were measured for trees of the HB group (916 ppm) compared to other trees with high root water uptake rates (average of 1740 ppm). Similarly to Ag and Ca, phloem buildup values for all experimental groups were negative and high Ba redistribution might be expected (Table 4).

Br

Bromine in outer bark and twigs is present in similar concentrations (30.9 ppm and 24.3 ppm, respectively). Lower Br concentrations were measured in trees of the HB group (17.6 ppm) compared to trees of the DS, WB and DB groups (average = 34. 2 ppm). A good correlation between Br concentrations in crowns and root water uptake exists for trees growing on poorly drained or semi-wet sites (Appendix 6). Thin and thick twigs exhibited no difference in Br content.

Cd

Cadmium concentrations in crown twigs were close to the detection limit and therefore results are tenuous. There were no differences in Cd contents between thin and thick twigs (1.4 ppm and 1.0 ppm, respectively, Table 4). Seasonal analyses show good correlations between Cd concentrations in twigs and root water uptake singularly for trees of the DB group (Appendix 5). The projection of Cd content in twigs to the Cd crown content was not possible because of the lack of data above the detection limits (Fedikow and Dunn, 1996). Cadmium was measured in higher concentrations in the outer bark (average = 2.3 ppm) compared to twigs (1.3 ppm).

Cr

A high SD was measured for the INA analysis of Cr (Appendix 5); similar to the average SD for multiple samplings for the DS group (3.54 ppm and 4.12 ppm, respectively) and for the WB group (3.54 ppm and 4.71 ppm, respectively). A relatively high SD was noted for the rest of the experimental groups (approximately 60% of the average SD for multiple samplings, Appendix 5). High SD values suggest that the observed differences in experimental groups and seasonal variations are not significant. Nevertheless, Cr behaves similarly to Rb in terms of group behavior. Chromium in outer bark is approximately three times higher (40.3 ppm) than in twigs (13.8 ppm). No significant differences in the Cr content between thin and thick twigs were found (Table 4). A good correlation between Cr content in crowns and root water uptake was observed for all experimental groups.

Cs

The large SD in estimated Cs twig concentrations is attributable to numerous analyses at or below the lower

limit of determination. Calculated differences between experimental groups were not significant, but Cs reflects similar patterns common for pH sensitive elements — a tendency towards higher element accumulation in trees growing on well drained sites (1.5 ppm in DS group, 1.08 ppm in DB group and 1.08 ppm in HB group compared to 0.53 ppm in WS and 0.71 in WB group). A good correlation for Cs crown concentration changes with the root water uptake was obtained only for trees of the DS and HB groups (Appendix 5). Cesium contents in outer bark are similar to those in twigs (Table 11). Seasonal variation was close to variations obtained for multiple samplings (Appendix 5).

Hf

Hafnium was detected in twigs and outer bark in low concentrations tending to accumulate in thin twigs compared to thick twigs (2.24 ppm vs. 1.82 ppm, respectively). No differences between experimental groups were identified for Hf concentrations in twigs or crowns (Table 4). The outer bark of trees of the HB group contained more Hf (4.42 ppm) compared to the trees of the WB and DB groups (3.68 and 3.50 ppm, respectively). High phloem buildup values for all tested groups were observed. A good water flux-Hf crown concentration correlation was obtained only for trees of the WB and DS groups (Table 4, Appendix 5).

Na

Sodium concentrations in crown twigs is approximately five times lower than in the outer bark (1932 and 11 522 ppm, respectively). There was 50% more Na in the outer bark of HB trees compared to the rest of the tested trees (Table 8). Higher Na concentrations were detected in thin twigs (WS = 2365 ppm, WB = 2248 ppm, HB = 2630 ppm) compared to thick twigs (WS = 2043 ppm, WB = 1336 ppm and HB = 1709 ppm) in trees growing on wet or semi-wet sites (Table 4). Sodium also displayed large differences between thin and thick twigs and in this regard is similar to Ni, Au, As and Hf. Phloem buildup values were high for all experimental groups (Table 4). A good correlation between root water uptake and Na concentrations in crowns was obtained for trees with large transpiring areas (WB, DB and HB groups; Table 4, Appendix 5). Seasonal variations compared favorably with variations in multiple samplings (Appendix 5).

Pb

Outer bark contains up to ten times the amount of Pb as crown twigs (119 ppm vs. 10 ppm, respectively). A substantial difference was also found in the Pb concentration in thin and thick twigs with up to 60% greater Pb contents in thin twigs (Table 4). Relatively high phloem buildup values were documented in three out of five experimental groups. The absence of a Pb concentration factor for cones made the projection from twig to crown Pb contents impossible. A poor correlation for twig Pb contents with the root water uptake was found for trees of all experimental groups. The poor correlation might be also caused by possible Pb release to the atmosphere (Luxmore et al., 1978). The seasonal Pb variations were comparable with the variations obtained for multiple samplings (Table 4, Appendix 5)).

Sb

Antimony was measured in outer bark at about five times higher concentration than in twigs (0.76 ppm and 0.19 ppm, respectively). Additionally, thin twigs contained more Sb than the thick twigs in trees of the WB (0.21 ppm and 0.1 ppm, respectively) and HB (0.23 ppm and 0.15 ppm, respectively) groups. Poor correlation between root water uptake and the Sb crown concentration was found for trees with lower water flux rates, including trees of HB groups (Table 4, Appendix 5). The standard deviation for Sb twig content estimated by multiple samplings was very high making any conclusions questionable. Seasonal variations were within the limits of average SD (Table 4, Appendix 5). Overall Sb contents were low and close to the lower limit of detection.

Sc

Scandium concentrations are higher in thin twigs than in thick twigs in trees of the WB group (1.37 ppm and 0.9 ppm, respectively) and the HB group (1.1 ppm and 0.7 ppm, respectively). No further differences in averaged values were found, either for twigs or for the outer bark in the experimental groups. The Sc content of outer bark was about four times higher than that for twigs (3.9 ppm and 1.0 ppm, respectively). A good correlation between root water uptake and Sc concentrations in crowns was documented for trees with a large number of branches and high water fluxes (Table 4, Appendix 5). This observation was not observed for Sc contents in twigs.

Sr

Strontium is the only element for which higher concentrations were found in thin and thick twigs from trees growing on wet or semi-wet sites (WS = 935 ppm and 845 ppm, WB = 1087 ppm and 1080 ppm, and HB = 1268 ppm and 1117 ppm, respectively). Trees growing on dry sites (DS = 530 ppm and 432 ppm, DB = 676 ppm and 629 ppm, respectively) contained lower Sr. No differences between thin and thick twig Strontium contents were detected. Strontium displayed high seasonal fluctuations which correlated with the root water uptake for trees of the WB, DB and HB groups (Table 4, Appendix 5). The outer bark Sr concentrations were similar to those found for twigs, with higher Sr content in bark of trees of WB and WS groups (571 and 677 ppm, respectively) compared to DB and DS groups (362 and 296 ppm, respectively). Phloem buildup values calculated for Sr crown content were all negative, similar to those calculated for Ba, Ag and Ca with similar or higher element content in thick twigs as compared to thin twigs (Table 4).

Th

Thorium content in thin twigs from trees growing on wet sites (WS = 1.15 ppm, WB = 1.08 ppm and

HB = 1.2 ppm) was higher than in thick twigs (WS = 0.59 ppm, WB = 0.51 ppm and HB = 0.8 ppm). High phloem buildup values were calculated for four out of five experimental groups (Table 4). Thorium concentrations were much higher in outer bark compared to twigs (7.14 ppm and 0.88 ppm, respectively). Thorium content in crowns correlated with root water uptake only in trees of the HB group (Table 4, Appendix 5). Seasonal variations were similar to variations calculated for multiple samplings (Table 4, Appendix 5).

V

Vanadium is much higher in outer bark as compared to twigs (21.36 ppm vs. 4.93 ppm, respectively). No differences in twig or bark V concentrations within experimental groups were detected. Vanadium was more concentrated in thin twigs with higher proportion of bark than in thick twigs (5.9 ppm and 3.2 ppm, respectively). The correlation between water flux and V concentration in twigs was good in trees of WB and HB groups (Appendix 6). The SD values for multiple samplings were very high in WB. They were particularly high in the DS group, which also displayed the highest seasonal variations (Appendix 5).

W

Tungsten is present in concentrations 30 times greater than detection limit in crown twigs and below the lower limits of determination in the outer bark samples. Thin twigs contain slightly higher concentrations of tungsten than thick twigs (38.4 ppm and 25.3 ppm, respectively) along with moderate, positive, phloem buildup values in all experimental groups (Table 4). Very high seasonal fluctuations were detected for all experimental groups (Table 4, Appendix 5). The water flux- twig W content correlation was very good in trees growing on well-drained sites (Table 4, Appendix 5). As in the case of Sr, Mn, Zn or Rb, weather conditions should be monitored during the sampling season to correct for changing conditions.

Rare-earth elements (REEs): group C

The contents of the REEs Ce, La, Sm and Yb in crown twigs were higher (about 1.5 times) in thin twigs as compared to thick twigs (Table 5). The concentration of REEs in the crowns was the highest in trees of the DS group. The phloem buildup values were relatively high with the lowest value for WB trees. The outer bark concentrations were always about five times higher compared to twig concentrations (Table 12). An excellent correlation between REE contents in the crowns and the root water uptake was obtained for trees growing on poorly drained or semi-wet sites (Table 5, Appendix 8).

The REEs Eu, Lu and Nd were detected in the outer bark in measurable concentrations, whereas the twig concentration of these elements was < the detection limit. No differences were detected between experimental groups in the outer bark concentrations of these elements (Table 8).

Other elements: group D

Titanium, U, Y and Zr were present in measurable concentrations in outer bark but not detected in the twigs. Titanium, U and Zr were documented in higher concentrations in trees of the HB group; no differences between experimental groups were detected for Y (Table 8).

DISCUSSION

A number of different models of elemental uptake and incorporation into vegetation have been published (Luxmore et al., 1978; Dixon et al., 1978). Although the entire process is complex and affected by a number of parameters, including bulk water flow, a good correlation between element crown content and root water uptake should demonstrate the dominating role of bulk water flow in element accumulation in the crown. This is important because it demonstrates that element concentrations in soil and groundwater will be proportionally reflected in the crowns of black spruce. Although the correlation between crown element content and root water uptake will also be affected by analytical precision, a surprisingly good correlation was found for a majority of metals in more than one half of the experimental groups. Elemental concentrations of K, Mn, P and Zn in crown or twig samples correlate well with the root water uptake in trees growing on well drained sites. This was also observed for nonessential elements such as Ag, Co, As, Au, Cd and W. Silver, Co and Au displayed good correlation in all experimental groups, whereas no correlation for Pb was observed for any of the groups. The concentration of the remainder of the analyzed elements was highly correlated with the bulk water flux in trees growing on wet or semi-wet sites. The element concentration in the crowns was not measured directly, it was calculated from measured twig concentrations using season-independent parameters derived from a model tree (Fedikow and Dunn, 1996). It was assumed that the patterns of metal enrichment within the crown tissues are consistent and not necessarily dependent on the metal concentration in the soil (Fedikow and Dunn, 1996). The quality of this projection was very good, judging by the number of good correlations obtained. It was also demonstrated that root water uptake is correlated with the metal concentration in the crowns. For twigs, affected by metal redistribution in the crowns, this correlation was less well-developed (Appendices 2, 4, 6 and 8). It might be assumed that for those elements and experimental groups for which a poor correlation was obtained a significant season-dependent element crown redistribution occurs which could not be reflected using season-independent parameters.

Differences in average seasonal twig concentrations were found only in trees growing on sites which were well or poorly drained. No differences were detected between trees with a high number of branches (high water flow rates) and those with a low number of branches. It is clear that the element concentration in the soil allowed the equilibration of the crown concentration by the phloem transport to the roots and/or to other plant organs. Metals attached to the cell walls (Redy and

Patrick, 1977) and in equilibrium with xylem and phloem metal concentrations would satisfy the requirements for equilibrated phloem transport. The differences between metal concentration in crowns of trees growing on well or poorly drained sites was found only for pH-sensitive metals. These metals might have been mobilized from the soil surface, drained and concentrated in a layer directly accessible to tree roots. It is probable that this "concentrating" mechanism is generally applicable – with biogeochemical enrichment tending to occur down slope as has been reported by Dunn (1995). Similar experiments for trees growing on sites with multi-element soil enrichment is recommended.

High phloem buildup values were in most cases correlated with higher metal content in thin twigs relative to the metal content in thick twigs (i.e. Au) and at the same time low floem buildup values were calculated for trees where more metals were found in thick twigs (i.e. Ca, Ag) that are enriched in woody parts. This is in agreement with previously published results that indicate high accumulation of Ag and Ca in the trunk wood (Dunn, 1981) and high accumulation of Au in twigs with the most recent growth (Dunn and Scagel, 1989). It also suggests that twig bark retains some metals thereby serving as a temporary "storage place", before they are redistributed by the phloem. It also shows that for other metals (e.g. Ca, Ag) such binding potential is very low.

This relatively detailed analysis of the element concentration in thin and thick twigs may be very important in assisting the development of new biogeochemical exploration techniques. A normalization factor in respect to the twig type can be calculated and the ratio of thin and thick twigs in each sample is relatively easy to establish. Significant differences in element concentrations between thick and thin twigs were documented for a number of elements including Au.

Metal enrichment in outer bark compared to crown twigs was found for Co and Cs; in trees growing on wet or semi-wet sites (Tables 3, 4, 6 and 7). The concentration of these metals in twigs in these trees was about two times lower compared to the outer bark concentration in trees growing on dry sites (Tables 3, 4). No metal enrichment was detected in trees growing on dry sites (Tables 3, 4). Similar but somewhat lower differences were found for Ni (Table 3). Iron, As, Ba, Cd, Cr, Hf, Na, Pb, Sb, Sc, Th and V were found in higher concentrations in the outer bark in all experimental groups. Similar findings were reported previously (Fedikow and Dunn, 1996) with the exception that Pb, Cd, Cr and Hf were found in higher concentrations in twigs. However, the site quality, with regards to soil enrichment by metals, was different and black spruce trees in this study were not growing near a known mineral deposit. It could be speculated that multi-element soil enrichment might cause an increase of the relative Pb, Cd, Cr and Hf content in twigs compared to outer bark, and that phloem buildup values for these elements were relatively high (Table 4). One hundred bark samples were collected in this study with the intent of establishing the possible effect of the bark quality (fine, coarse, semi-coarse) on the accumulated metal content. Unfortunately only a quarter of the bark sample analyses were available at the time of writing this report which therefore precluded development of any final conclusions.

Outer bark formed by dead phloem cells will not accumulate metals in values that directly reflect the metal uptake by the roots and metal concentration in the xylem, but will reflect phloem metal flux through the tree trunk. Thus, higher element concentrations in the bark compared to the crown might indicate rich element transport from shoot to root. A large increase in element concentration for the youngest ring in the wood xylem was reported for Zn and Ca (Dilabio et al., 1982) indicating an element-rich phloem transport.

Conclusions drawn from this study could be generally applied only for similar element soil enrichment, considered as background concentrations. Trees growing in metal enriched soil might be exposed to concentrations inducing metal stress. Heavy metal stress reduces the root growth and transpiration rate, affecting the growth rate of the tree (Kahle, 1993). Higher metal concentrations will also affect the root absorption power (Kovalevskiy, 1990). Different defence mechanisms employed by trees to avoid metal stress (Kahle, 1993, Salt et al., 1998) can lead to different metal redistribution within the tree tissues in metal enriched soil. Important data offered by this study, including the effect of the site drainage and metal redistribution within thin and thick twigs for metals of high interest to mineral explorationists could be affected by significant soil enrichment in metals. Similar study on sites with metal soil enrichment is strongly recommended.

CONCLUSIONS

1. During the two-month sampling season no significant increase or decrease in crown metal content, other than those directly attributable to the water uptake changes, were observed. Vegetation samples are often sampled over a prolonged period of time. To date, no study has been undertaken to determine the extent or nature of changes in element concentration in metabolically active plant tissue, such as black spruce crowns. This uncertainty may be responsible for decreased confidence in the results of biogeochemical surveys based on such vegetation samples. Based on this study the seasonal changes identified for some elements are attributed to the root water uptake rate and thus to the weather conditions. Explorationists might use this data set for evaluation of the element of interest in terms of seasonal variations and impact of the weather conditions.
2. Maxima or minima in crown element content were not attributable to a particular seasonal period, as would be expected if they were dependent on the crown development stage. The leader length indicative of the metabolic activity of the crown was not correlated with metal concentration. The nature of seasonal changes of element concentrations was shown to be unrelated to the metabolic changes occurring in the black spruce crown during the growth season. This is

an important observation for explorationists when they compare results obtained from tree crowns growing in areas with different onset of crown growth or comparing data from different years sampling programs.

3. The element content in the crowns was correlated with the root water uptake for the majority of metals regardless of experimental groups and indicates good soil-crown correlation. Good soil-crown correlation is essential for the use of black spruce crowns as a reliable biogeochemical survey media. For those elements exhibiting large variations directly correlated with water uptake, a normalization based on weather conditions is recommended.
4. The crown morphology (wide, narrow, packed, loose crown) did not affect the crown metal concentration. Variation in the morpholoogy of black spruce crowns does not compromise the accuracy of the data and is therefore very important for biogeochemical exploration.
5. The crown concentration of important elements such as Ag, Co, Ni and Rb is directly related to the site drainage. Careful evaluation of the sampling site is strongly recommended with elemental concentration normalized to site drainage type. The demonstrated importance of sampling site drainage is a very important result of this study. If Ag, Co, Ni and Rb as well as the essential elements Mn and Cu are the elements of interest, vegetation samples must be collected from trees of similar drainage in order not to compromise the interpretation of the results.
6. For some elements high phloem buildup values were measured, reaching in some cases 10% of elemental crown content per day (i.e. Au, As). Thus, where possible, it might be useful to cut the phloem pathway and let the crown twigs concentrate the element of interest.
7. Nickel, Au, Pb, Th, W, Ce, Sm and Yb were found in significantly higher concentrations in thin twigs compared to thick twigs in the black spruce crown. Careful sampling is recommended when these are the metals of interest. From data obtained by this study it is possible to adjust the sampling technique according to the element of interest. If the element of interest is Au, the study recommends separating thin and thick twigs. If it is Rb, there is no need for it, because differences in thin and thick twigs were not detected.
8. Higher seasonal variability was measured for essential elements and pH sensitive elements compared to the rest of the heavy and REE metals. This result can be useful to explorationists when elements of interest fall into the non-pH sensitive or REEs category. Sampling can be undertaken during any weather conditions without compromising data reliability.

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Appendix 1. Ca-DS

sampling date	Ca	ash	Tw (%)	CR (%)	(%)
9.7	DS0	13.25	0.270325		0.252281469
24.7	DS00	14.9	0.32482	0.200574174	
6.6	DS1	16.66146082		0.354375568	0.272016796
12.6	DS2	18.5	0.44955	0.191591158	
16.6	DS3	16.4	0.3444	0.221751583	
21.6	DS4	17.45	0.37876	0.262389645	
26.6	DS5	13.4	0.30284	0.213005272	
3.7	DS6	16.36741504		0.363537258	0.226797046
9.7	DS7	13	0.2899	0.182539696	
13.7	DS8	15	0.3	0.249161725	
18.7	DS9	15.85	0.3226	0.201907425	
24.7	DS10	18.41991574		0.340471148	0.268415474
31.7	DS11	19.2	0.42444	0.340089736	
DS	average	16.38625378		0.351897634	0.239060505
	st.dev(5)	2.542220419		0.076635623	0.07768098
	st.dev(2)a		1.626345597	0.074613908	0.044102178
	st.dev(2)b		0.070710678	0.024975012	0.014367518
	stdev(2)c		2.121320344	0.014509831	0.061149791
	stdev(A)	0.989949494		0.022273864	0.012563471
	av.st.dev(2)		1.272792206	0.038032917	0.039873162
	season SD		2.008043939	0.050646264	0.045561144
	median	16.4	0.3444	0.226797046	
	average SD		1.590149259	0.047683593	0.049325117
	average SD(%)		9.704165946	13.55041603	20.63290071

Appendix 1. Ca-HB

sampling date	Ca	ash (%)	Tw (%)	CR (%)	(%)
31.7	HB0	15.4	0.35574	0.162039888	
18.7	HB00	12.45	0.2614	0.117266186	
8.6	HB1	17.27376606		0.375097614	0.282831735
12.6	HB2	16.5	0.40755	0.250309328	
16.6	HB3	19.6	0.4704	0.351057087	
21.6	HB4	17.65	0.40785	0.290536251	
26.6	HB5	16.5	0.31845	0.138654534	
3.7	HB6	15.3	0.32895	0.264402086	
9.7	HB7	16.4	0.40016	0.251976253	
13.7	HB8	14.25256151		0.285246694	0.156275612
18.7	HB9	17.8	0.36864	0.185712419	
24.7	HB10	15.72000265		0.311010675	0.155971263
31.7	HB11	16.12650844		0.298281818	0.226019497
HB	average	16.64753079		0.361057891	0.232158733
	stdev(5)	2.207479178		0.050046558	0.07418707
	stdev(A)	0.989949494		0.020788939	0.014972687
	stdev(2)a		0.777817459	0.064106301	0.031103968
	stdev(2)b		2.545584412	0.055210897	0.048487751
	stdev(2)c		0.109380252	0.014621122	0.026674794
	stdevdouble		0.353553391	5.282998409	0.00914645
	avrstdev(2)		1.144260708	0.044646107	0.035422171
	season SD		1.422345487	0.057558264	0.066614625
	median	16.5	0.36864	0.250309328	
	average SD		1.410065325	0.04599622	0.045113396
	average SD(%)		8.470116941	12.73929217	19.43213381

Appendix 1. Ca-WB

sampling date	Ca	ash	Tw (%)	CR (%)	(%)
24.7	WB0	8.5	0.26605	0.197080493	
31.7	WB00	15.45	0.30591	0.126593891	
6.6	WB1	18.61026087		0.396843692	0.282196949
12.6	WB2	18	0.4284	0.201801788	
16.6	WB3	19.6	0.45472	0.17619906	
21.6	WB4	17.9	0.402595		0.299588554
26.6	WB5	15.6	0.351	0.152075342	
3.7	WB6	18.4	0.4232	0.345038776	
9.7	WB7	19.3	0.58672	0.465259997	
13.7	WB8	17	0.3706	0.185190066	
18.7	WB9	15.45	0.307915		0.212522895
26.6	WB10	18.64668455		0.402411835	0.320335543
31.7	WB11	18.79052095		0.437412638	0.333725907
WB	average	17.93613331		0.414710742	0.270357716
	st.dev(5)	1.237155092		0.048300478	0.110457297
	st.dev.(A)		0.070710678	0.001400071	0.002377432
	st.dev(2)a		3.111269837	0.098648467	0.139484451
	st.dev(2)b		1.202081528	0.055543238	0.01378674
	st.dev(2)c		1.486529512	0.132705078	0.174881648
	st.dev(A)2		0.168924961	0.004522872	0.003894025
	avst.dev(2)		1.933293626	0.095632261	0.10938428
	season SD		1.380332355	0.070703746	0.094460025
	median	18.4	0.402595		0.282196949
	average SD		1.759258992	0.083799315	0.109652534
	average SD(%)		9.808462963	20.20669028	40.55831495

Appendix 1. Cu-DB

sampling date	Cu	ash	Tw (ppm)	(ppm)
13.7	DB0	244	4.88	
31.7	DB00	203	4.3087	
8.6	DB1	208.0184652		4.793866667
12.6	DB2	150.7500428		3.549
16.6	DB3	178.4254318		4.192
21.6	DB4	219	5.1147	
26.6	DB5	236	4.838	
3.7	DB6	182.0397803		4.04322
9.7	DB7	285	5.9565	
13.7	DB8	167.8190273		3.2536
18.7	DB9	148.125745		3.205
24.7	DB10	152.2231175		3.145
31.7	DB11	177.0615445		3.8414
DB	average	191.3148322		4.175662424
	st,dev(5)	30.66642352		0.602546722
	stdev(2)a		1.414213562	0.029557063
	stdev(2)b		8.307451052	0.394699835
	stdev(2)c		13.85386004	0.069296465
	stdev(A)	1.414213562		0.029557063
	stdevdouble(a)		23.20396816	0.302641702
	stdevdouble(b)		9.899494937	0.578130504
	stdevdouble(c)		1.414213562	0.001838478
	stdevdouble(d)		26.87005769	0.342663946
	avstdevdouble		15.34693359	0.306318658
	avstdev(2)		7.858508218	0.164517788
	season SD		42.2675864	0.908346649
	median	178.4254318		4.04322
	average SD		13.56048704	0.274025021
	average SD (%)		7.08804795	6.562432339

Appendix 1. Cu-DS

sampling date	Cu	ash	Tw (ppm)	(ppm)
9.7	DS0	171	3.4911	
24.7	DS00	236	5.1448	
6.6	DS1	201.4781109		4.594177778
12.6	DS2	228	5.5404	
16.6	DS3	182	3.822	
21.6	DS4	214	4.696	
26.6	DS5	172	3.8872	
3.7	DS6	171.7524506		3.8148
9.7	DS7	156	3.4788	
13.7	DS8	366	7.32	
18.7	DS9	241	4.897	
24.7	DS10	204.9571871		3.7884
31.7	DS11	186	4.1316	
DS	average	211.1988862		4.542761616
	st.dev(5)	57.54287398		1.244436224
	st.dev(2)a		65.05382387	1.889389319
	st.dev(2)b		9.899494937	0.15641202
	stdev(2)c		2.828427125	0.378443549
	stdev(A)	9.899494937		0.222738636
	av.st.dev(2)		25.92724864	0.80808163
	season SD		57.36036696	1.10495529
	median	201.4781109		4.1316
	average SD		33.83115498	0.917170278
	average SD (%)		16.01862376	20.1897074

Appendix 1. Cu-HB

sampling date		Cu ash	Tw (ppm)	(ppm)
31.7	HB0	244	5.6364	
18.7	HB00	138	2.8948	
8.6	HB1	143.0790809		3.0936
12.6	HB2	140	3.458	
16.6	HB3	158	3.792	
21.6	HB4	146	3.3764	
26.6	HB5	126	2.4318	
3.7	HB6	136	2.924	
9.7	HB7	126	3.0744	
13.7	HB8	80.9444952		1.62
18.7	HB9	128	2.6496	
24.7	HB10	74.60426858		1.476
31.7	HB11	103.6774557		2.282533333
HB	average	123.8459364		2.743484848
	stdev(5)	22.29782655		0.355989101
	stdev(A)	2.828427125		0.05939697
	stdev(2)a		8.485281374	0.577564819
	stdev(2)b		0	0.018101934
	stdev(2)c		17.77848313	0.590728409
	stdevdouble		22.627417	0.436143463
	avrstdev(2)		8.754588167	0.395465054
	season SD		26.71043021	0.739076643
	median	128	2.924	
	average SD		12.14039776	0.385596066
	average SD (%)		9.802822858	14.0549734

Appendix 1.	Cu	Cu-WB ash	Tw (ppm)	(ppm)
sampling date				
24.7	WB0	124	3.8812	
31.7	WB00	178	3.5244	
6.6	WB1	169.5640029		3.696825
12.6	WB2	160	3.808	
16.6	WB3	174	4.0368	
21.6	WB4	220	4.8733	
26.6	WB5	132	2.97	
3.7	WB6	174	4.002	
9.7	WB7	160	4.864	
13.7	WB8	116	2.5288	
18.7	WB9	185	3.7114	
26.6	WB10	110.3198831		2.3808
31.7	WB11	92.67916579		2.3067
WB	average	153.9602774		3.561693182
	st.dev(5)	58.17311178		0.9719529
	st.dev.(A)	0		0
	st.dev(2)a	53.74011537		0.843295547
	st.dev(2)b	38.18376618		1.137310547
	st.dev(2)c	11.27343585		0.22528422
	st.dev(A)2	17.74736257		0.475175757
	avst.dev(2)	34.3991058		0.735296772
	season SD	37.45319499		0.912345198
	median	160	3.7114	
	average SD	40.34260729		0.794460804
	average SD (%)	26.20325708		22.30570583

Appendix 1. Cu-WS

sampling date		Cu (ppm)	ash (ppm)	Tw
24.7	WS0	200	4.24	
31.7	WS00	196	3.5868	
6.6	WS1	134.5187757		2.0584
12.6	WS2	138	3.1188	
16.6	WS3	144	3.0528	
21.6	WS4	139	2.749	
26.6	WS5	166	3.5524	
3.7	WS6	148.2128357		3.3659
9.7	WS7	136	2.8832	
13.7	WS8	145	3.0595	
18.7	WS9	149.6047182		3.062133333
24.7	WS10	113.5918159		2.2517
31.7	WS11	99.84710276		2.429733333
WS	average	137.6159317		2.871233333
	st.dev(5)	17.05419281		0.414434803
	st.dev.(A)		1.414213562	0.029839906
	st.dev2a	62.7844097		0.956424515
	st.dev.2b		11.89096794	0.180029386
	st.dev.2c	5.914765162		0.691952494
	st.dev.double		11.89096794	0.180029386
	av.st.dev(2)		26.86338093	0.609468798
	season SD		17.81816726	0.461449024
	median	139	3.0528	
	average SD		24.4110839	0.5607103
	average SD (%)		17.73859949	19.52855217

Appendix 1. Fe-DB

sampling	date	Fe	ash	Tw (%)	CR (%)	(%)
13.7	DB0	0.28	0.0056	0.002366285		
31.7	DB00	0.56	0.012056		0.004204512	
8.6	DB1	0.212178835		0.005844		0.002591737
12.6	DB2	0.281620959		0.00663	0.00285545	
16.6	DB3	0.479518348		0.011266		0.004363834
21.6	DB4	0.375	0.0088375		0.003999511	
26.6	DB5	0.35	0.007175		0.003075969	
3.7	DB6	0.269851151		0.006074		0.002381208
9.7	DB7	0.345	0.0072105		0.003394812	
13.7	DB8	0.496607326		0.009628		0.004222108
18.7	DB9	0.264550512		0.004746333		0.002058912
24.7	DB10	0.268629031		0.00555	0.002805259	
31.7	DB11	0.286638391		0.007024		0.002526533
DB	average	0.329963141		0.007271394		0.003115939
	st,dev(5)	0.058611596		0.001689771		0.000283738
	stdev(2)a		0.007071068		0.000147785	0.000107702
	stdev(2)b		0.020577532		0.00108412	0.000288282
	stdev(2)c		0.067205135		0.001797465	0.001083345
	stdev(A)	0.007071068		0.000147785		0.000107702
	stdevdouble(a)		0.007131049		8.76812E-05	7.92309E-05
	stdevdouble(b)		0.042426407		0.000427092	0.000213874
	stdevdouble(c)		0.084852814		0.002002526	0.000628926
	stdevdouble(d)		0.22627417		0.005453207	0.002159835
	avstdevdouble		0.09017111		0.001992627	0.000770467
	avstdev(2)		0.031617912		0.00100979	0.00049311
	season SD		0.090848349		0.001930261	0.00078004
	median	0.286638391		0.007024		0.00285545
	average SD		0.038366333		0.001179785	0.000440767
	average SD(%)		11.62746014		16.22502459	14.14555605

Appendix 1. Fe-DS

sampling date	Fe	ash	Tw (%)	CR (%)	(%)
9.7	DS0	0.62	0.012792		0.006869949
24.7	DS00	0.81	0.017658		0.007075238
6.6	DS1	0.385768162		0.008806667	0.003956335
12.6	DS2	0.26	0.006318		0.002321444
16.6	DS3	0.71	0.01491	0.006249719	
21.6	DS4	0.365	0.007796		0.003260583
26.6	DS5	0.35	0.00791	0.00332366	
3.7	DS6	0.30309256		0.006732	0.002488506
9.7	DS7	0.24	0.005352		0.002217679
13.7	DS8	0.56	0.0112	0.005549867	
18.7	DS9	0.425	0.0088115		0.00352084
24.7	DS10	0.328286404		0.006068	0.002898635
31.7	DS11	0.43	0.009378		0.004456847
DS	average	0.396104284		0.008480197	0.003658556
	st.dev(5)	0.064834218		0.001841261	0.000523261
	st.dev(2)a		0.077781746	0.000854185	0.000713654
	st.dev(2)b		0.219203102	0.005091876	0.001796253
	stdev(2)c		0.197989899	0.003665642	0.002314776
	stdev(A)	0.007071068		0.000159099	6.89429E-05
	av.st.dev(2)		0.164991582	0.003203901	0.001608228
	season SD		0.136645342	0.002718289	0.001308324
	median	0.365	0.00791	0.00332366	
	average SD		0.139952241	0.002863241	0.001336986
	average SD(%)		35.33217052	33.76384838	36.54409192

Appendix 1. Fe-HB

sampling date	Fe	ash	Tw (%)	CR (%)	(%)
31.7	HB0	0.39	0.009009		0.002825071
18.7	HB00	0.69	0.014468		0.004881853
8.6	HB1	0.343579185		0.0076056	0.003293448
12.6	HB2	0.45	0.011115		0.004921493
16.6	HB3	0.33	0.00792	0.00418475	
21.6	HB4	0.385	0.0086245		0.003997066
26.6	HB5	0.44	0.008492		0.003227662
3.7	HB6	0.54	0.01161	0.005104812	
9.7	HB7	0.46	0.011224		0.004871368
13.7	HB8	0.296796482		0.00594	0.002081374
18.7	HB9	0.42	0.008698		0.003147624
24.7	HB10	0.300236691		0.00594	0.002300061
31.7	HB11	0.367916667		0.007559333	0.00260045
HB	average	0.393957184		0.008611676	0.003611828
	stdev(5)	0.161723336		0.003991229	0.001890473
	stdev(A)	0.007071068		0.000148492	6.97042E-05
	stdev(2)a		0.190918831	0.003393405	0.001467072
	stdev(2)b		0.056568542	0.001230366	0.000523296
	stdev(2)c		0.010770858	0.002472497	0.000370107
	stdevdouble		0.155563492	0.046533849	0.000920372
	avrstdev(2)		0.086086077	0.002365423	0.000786825
	season SD		0.075656897	0.001974246	0.001075065
	median	0.385	0.008492		0.003293448
	average SD		0.104995392	0.002771874	0.001062737
	average SD(%)		26.65147278	32.18739617	29.42380279

Appendix 1. Fe-WB

		Fe ash	Tw (%)	CR (%)	
sampling date					
24.7	WB0	0.12	0.003756		0.001739513
31.7	WB00	0.36	0.007128		0.002268958
6.6	WB1	0.324738011		0.007621125	0.003069518
12.6	WB2	0.35	0.00833	0.003010654	
16.6	WB3	0.31	0.007192		0.0020678
21.6	WB4	0.335	0.00747	0.003121115	
26.6	WB5	0.26	0.00585	0.002252443	
3.7	WB6	0.34	0.00782	0.003978485	
9.7	WB7	0.18	0.005472		0.003038357
13.7	WB8	0.32	0.006976		0.002332163
18.7	WB9	0.355	0.0070105		0.002761557
26.6	WB10	0.240212649		0.005184	0.002261808
31.7	WB11	0.268738934		0.006889	0.002435962
WB	average	0.298517236		0.006892239	0.00275726
	st.dev(5)	0.305807245		0.005573355	0.002992094
	st.dev.(A)		0	0	4.96318E-05
	st.dev(2)a		0.021213203		7.07107E-05 0.000254718
	st.dev(2)b		0.035355339		2.6163E-05 0.000383378
	st.dev(2)c		0.119389857		0.001347038 0.000308687
	st.dev(A)2		0.005546051		0.000148492 6.67294E-05
	avst.dev(2)		0.0586528		0.000481304 0.000315595
	season SD		0.05476273		0.000996256 0.00055894
	median	0.32	0.0070105		0.002761557
	average SD		0.120441411		0.001754317 0.000984719
	average SD(%)		40.34655179		25.4535126 35.7136951

Appendix 1. Fe-WS

sampling date	Fe	ash (%)	Tw (%)	CR (%)	
24.7	WS0	0.51	0.010812	0.004913318	
31.7	WS00	0.47	0.008601	0.003352866	
6.6	WS1	0.267416843	0.004092	0.002104196	
12.6	WS2	0.43	0.009718	0.006862022	
16.6	WS3	0.4	0.00848	0.003644253	
21.6	WS4	0.4	0.0080125	0.002883084	
26.6	WS5	0.41	0.008774	0.002945681	
3.7	WS6	0.404398671	0.0088215	0.002953048	
9.7	WS7	0.36	0.007632	0.002662043	
13.7	WS8	0.385	0.0081235	0.002794075	
18.7	WS9	0.298806696	0.006354667	0.002226523	
24.7	WS10	0.33462429	0.0066225	0.002711815	
31.7	WS11	0.273913071	0.007900667	0.002500945	
WS	average	0.360378143	0.007684667	0.003117062	
	st.dev(5)	0.065391829	0.001366987	0.00040275	
	st.dev.(A)	0.021213203	0.000447599	0.000153951	
	st.dev2a	0.026596685	0.000412317	1.24513E-05	
	st.dev.2b	0.07831308	0.001389465	0.000691729	
	st.dev.2c	0.013913392	0.004030033	0.000153185	
	st.dev.double	0.07831308	0.001389465	0.000691729	
	av.st.dev(2)	0.039607719	0.001943938	0.000285788	
	season SD	0.057936013	0.001529702	0.001307204	
	median	0.385	0.0080125	0.002794075	
	average SD	0.046053747	0.0017997	0.000315029	
	average SD(%)	12.77928407	23.41936721	10.10658938	

Appendix 1. K-DB

	K	ash	Tw	CR	
sampling date			(%)	(%)	(%)
13.7	DB0	27.3	0.546	0.682719964	
31.7	DB00	20.35	0.432295		0.275312049
8.6	DB1	13.72921871		0.3279	0.296289413
12.6	DB2	13.16992132		0.31005	0.303080566
16.6	DB3	14.38555044		0.33798	0.278033206
21.6	DB4	20.15	0.470815		0.658526032
26.6	DB5	16.6	0.3403	0.422438529	
3.7	DB6	17.78736754		0.397895	0.362992626
9.7	DB7	21.3	0.44517	0.506676732	
13.7	DB8	20.03553693		0.38844	0.491782444
18.7	DB9	16.10342181		0.302146667	0.31753088
24.7	DB10	14.59551068		0.30155	0.499033433
31.7	DB11	17.97037601		0.39256	0.416437668
DB	average	16.89335486		0.364982424	0.413892866
	st,dev(5)	1.403028383		0.057975425	0.063699988
	stdev(2)a		1.414213562	0.029557063	0.034253826
	stdev(2)b		3.964637141	0.061405004	0.177781962
	stdev(2)c		2.302031397	0.026502362	0.032076215
	stdev(A)	1.414213562		0.029557063	0.034253826
	stdevdouble(a)		1.477055525	0.012558216	0.034813223
	stdevdouble(b)		1.626345597	0.002743574	0.029618506
	stdevdouble(c)		2.474873734	0.052347115	0.00190757
	stdevdouble(d)		2.050609665	0.020654589	0.009861106
	avstdevdouble		1.90722113	0.022075874	0.019050101
	avstdev(2)		2.560294033	0.03915481	0.081370668
	season SD		2.793058136	0.058075498	0.117598338
	median	16.6	0.3403	0.416437668	
	average SD		2.270977621	0.043859964	0.076952998
	average SD(%)		13.44302325	12.01700706	18.59249193

Appendix 1. K-DS

	K	ash	Tw	CR	
sampling date			(%)	(%)	(%)
9.7	DS0	25.65	0.51954	0.784356745	
24.7	DS00	21.2	0.46216	0.430495627	
6.6	DS1	17.12789987		0.396372222	0.422286686
12.6	DS2	14.3	0.34749	0.181623753	
16.6	DS3	19.6	0.4116	0.398615023	
21.6	DS4	18.75	0.40444	0.443780363	
26.6	DS5	20	0.452	0.501965593	
3.7	DS6	19.53263164		0.43384	0.430284362
9.7	DS7	26.7	0.59541	0.561732987	
13.7	DS8	21.1	0.422	0.552686569	
18.7	DS9	20.95	0.42691	0.400686653	
24.7	DS10	17.745211		0.328	0.405345259
31.7	DS11	16.95	0.38031	0.473768038	
DS	average	19.34143114		0.418033838	0.433888662
	st.dev(5)	3.174333922		0.084534248	0.141239876
	st.dev(2)a		0.494974747	0.031734952	0.039094819
	st.dev(2)b		0.777817459	0.046937748	0.031570027
	stdev(2)c		4.737615434	0.133940166	0.099968738
	stdev(A)	1.060660172		0.023864854	0.018046345
	av.st.dev(2)		2.003469213	0.070870956	0.056877861
	season SD		3.151160474	0.0693984	0.101846111
	median	19.53263164		0.4116	0.430284362
	average SD		2.296185391	0.074286779	0.077968365
	average SD(%)		11.87184844	17.77051807	17.969671

Appendix 1. K-HB

sampling date	K	ash (%)	Tw (%)	CR (%)	
31.7	HB0	21.1	0.48741	0.324144855	
18.7	HB00	22.45	0.47198	0.287660824	
8.6	HB1	13.85623273		0.300786	0.355516356
12.6	HB2	21.7	0.53599	0.46280153	
16.6	HB3	20.2	0.4848	0.512573551	
21.6	HB4	15.55	0.35482	0.381848373	
26.6	HB5	20.4	0.39372	0.210083825	
3.7	HB6	16.3	0.35045	0.463015235	
9.7	HB7	18.7	0.45628	0.417824889	
13.7	HB8	17.17822065		0.3438	0.288135321
18.7	HB9	18.8	0.38893	0.271901213	
24.7	HB10	23.92795443		0.4734	0.324101049
31.7	HB11	18.83595957		0.363026667	0.405282065
HB	average	18.67712431		0.404182061	0.372098492
	stdev(5)	3.569669057		0.076231939	0.110223315
	stdev(A)	1.555634919		0.032668333	0.035266049
	stdev(2)a		2.757716447	0.022881975	0.061496528
	stdev(2)b		3.252691193	0.064671986	0.001475021
	stdev(2)c		0.772342498	0.062001049	0.026512901
	stdevdouble		3.74766594	17.46857805	0.014998471
	avrstdev(2)		2.260916713	0.04985167	0.02982815
	season SD		2.880184543	0.072852067	0.092428369
	median	18.8	0.38893	0.381848373	
	average SD		2.588104799	0.056446737	0.049926941
	average SD(%)		13.85708397	13.96567116	13.41766826

Appendix 1. K-WB

sampling date	K	ash	Tw (%)	CR (%)	(%)
24.7	WB0	31.3	0.97969	1.110460389	
31.7	WB00	21	0.4158	0.233511329	
6.6	WB1	14.093229		0.32937	0.309571477
12.6	WB2	16.2	0.38556	0.24553867	
16.6	WB3	18.5	0.4292	0.231386905	
21.6	WB4	16.65	0.368965		0.417076219
26.6	WB5	20.1	0.45225	0.235938995	
3.7	WB6	17	0.391	0.488864962	
9.7	WB7	25.4	0.77216	0.8719644	
13.7	WB8	22.5	0.4905	0.36412492	
18.7	WB9	18.8	0.367235		0.435846082
26.6	WB10	17.25972365		0.37248	0.488112954
31.7	WB11	13.24473372		0.327845	0.366568559
WB	average	18.15888058		0.426051364	0.404999468
	st.dev(5)	3.169271137		0.110418876	0.117392833
	st.dev.(A)		1.555634919	0.030801571	0.015219702
	st.dev(2)a		3.889087297	0.059842447	0.063648934
	st.dev(2)b		5.798275606	0.076544309	0.210721278
	st.dev(2)c		1.371743044	0.037717076	0.153302724
	st.dev(A)2		1.386512701	0.037123106	0.053650875
	avst.dev(2)		3.686368649	0.058034611	0.142557645
	season SD		3.528714393	0.124935636	0.181521227
	median	17.25972365		0.38556	0.366568559
	average SD		3.557094271	0.071130677	0.136266442
	average SD(%)		19.58873101	16.69532899	33.64607932

Appendix 1. K-WS

sampling date	K	ash (%)	Tw (%)	CR (%)
24.7	WS0	17.8	0.37736	0.39846926
31.7	WS00	23.5	0.43005	0.343867607
6.6	WS1	17.42261251	0.2666	0.288570084
12.6	WS2	15.6	0.35256	0.264058823
16.6	WS3	15.2	0.32224	0.289254485
21.6	WS4	16.85	0.331355	0.286442707
26.6	WS5	17.1	0.36594	0.233158401
3.7	WS6	19.31528356	0.4128475	0.337085512
9.7	WS7	27.6	0.58512	0.442466314
13.7	WS8	23.25	0.490575	0.327858231
18.7	WS9	23.76497711	0.46879	0.339818335
24.7	WS10	21.06490462	0.41813	0.484561856
31.7	WS11	14.37217427	0.348763333	0.377031891
WS	average	19.23090473	0.396629167	0.33366424
	st.dev(5)	2.07649274	0.043900771	0.082322417
	st.dev.(A)	1.626345597	0.034315892	0.022933797
	st.dev2a	1.605164762	0.053428563	0.012329093
	st.dev.2b	0.091788989	0.012204663	0.009210457
	st.dev.2c	1.063645151	0.098299551	0.008741821
	st.dev.double	0.091788989	0.012204663	0.009210457
	av.st.dev(2)	0.920199634	0.054644259	0.01009379
	season SD	4.202876122	0.090644483	0.075996015
	median	17.42261251	0.36594	0.327858231
	average SD	1.20927291	0.051958387	0.028150947
	average SD(%)	6.288174827	13.09999145	8.436908604

Appendix 1. Mg-DB

sampling date	Mg	ash (%)	Tw (%)
13.7	DB0	3.96	0.0792
31.7	DB00	6.23	0.131795
8.6	DB1	4.776103962	0.098376667
12.6	DB2	3.859863732	0.09087
16.6	DB3	5.531188386	0.129952
21.6	DB4	4.49	0.104049
26.6	DB5	5.4	0.1107
3.7	DB6	4.972762317	0.1100738
9.7	DB7	4.8	0.10032
13.7	DB8	4.931824475	0.095616
18.7	DB9	4.86071695	0.09924
24.7	DB10	2.775833319	0.05735
31.7	DB11	4.10756822	0.083448
DB	average	4.591441942	0.098181406
	st,dev(5)	0.816013636	0.013348256
	stdev(2)a	0.056568542	0.001182283
	stdev(2)b	1.271778286	0.021542256
	stdev(2)c	1.026261075	0.016707519
	stdev(A)	0.056568542	0.001182283
	stdevdouble(a)	0.521346534	0.006375275
	stdevdouble(b)	0	0.007800802
	stdevdouble(c)	0.664680374	0.014092638
	stdevdouble(d)	1.598061325	0.026990266
	avstdevdouble	0.696022058	0.013814745
	avstdev(2)	0.784869301	0.013144019
	season SD	0.776165328	0.018143844
	median	4.8	0.09924
	average SD	0.792655385	0.013195078
	average SD (%)	17.26375711	13.43948815

Appendix 1. Mg-DS

sampling date	Mg	ash (%)	Tw (%)
9.7	DS0	2.865	0.0582715
24.7	DS00	4.56	0.099408
6.6	DS1	3.517671075	0.078108222
12.6	DS2	3.08	0.074844
16.6	DS3	3.52	0.07392
21.6	DS4	5.78	0.12248
26.6	DS5	4.92	0.111192
3.7	DS6	4.613742302	0.102476
9.7	DS7	5.68	0.126664
13.7	DS8	3.54	0.0708
18.7	DS9	4.81	0.097621
24.7	DS10	3.744239522	0.069208
31.7	DS11	3.82	0.085548
DS	average	4.275059354	0.092078293
	st.dev(5)	0.814392958	0.015516287
	st.dev(2)a	2.093036072	0.032130932
	st.dev(2)b	0.353553391	5.23259E-05
	stdev(2)c	0.876812409	0.02594799
	stdev(A)	0.169705627	0.003818377
	av.st.dev(2)	1.107800624	0.019377083
	season SD	0.930408517	0.021130477
	median	3.82	0.085548
	average SD	1.034448707	0.018411884
	average SD (%)	24.19729463	19.99590056

Appendix 1. Mg-HB

sampling date	Mg	ash (%)	Tw (%)
31.7	HB0	3.88	0.089628
18.7	HB00	5.48	0.115132
8.6	HB1	5.939952491	0.129496
12.6	HB2	4.46	0.110162
16.6	HB3	3.52	0.08448
21.6	HB4	5.71	0.133262
26.6	HB5	4.54	0.087622
3.7	HB6	7.6	0.1634
9.7	HB7	4.7	0.11468
13.7	HB8	6.58348561	0.13176
18.7	HB9	5.01	0.103726
24.7	HB10	4.80378705	0.09504
31.7	HB11	5.067010636	0.105285333
HB	average	5.266748708	0.114446667
	stdev(5)	1.147800516	0.027057336
	stdev(A)	0.183847763	0.003860803
	stdev(2)a	1.258650071	0.043950929
	stdev(2)b	0.268700577	0.006270623
	stdev(2)c	0.947502491	0.013729921
	stdevdouble	0.367695526	0.009271584
	avrstdev(2)	0.824951046	0.021317158
	season SD	1.12689945	0.023426775
	median	5.01	0.110162
	average SD	0.905663414	0.022752202
	average SD (%)	17.1958729	19.88017922

Appendix 1. Mg-WB

sampling date	Mg	ash (%)	Tw (%)
24.7	WB0	4.24	0.132712
31.7	WB00	5.51	0.109098
6.6	WB1	4.815087037	0.1125315
12.6	WB2	4.78	0.113764
16.6	WB3	4.5	0.1044
21.6	WB4	6.18	0.136467
26.6	WB5	6.06	0.13635
3.7	WB6	5.82	0.13386
9.7	WB7	2.86	0.086944
13.7	WB8	5.42	0.118156
18.7	WB9	7.3	0.146094
26.6	WB10	5.604961805	0.12096
31.7	WB11	4.466080062	0.108882
WB	average	5.255102628	0.119855318
	st.dev(5)	1.372160238	0.025176964
	st.dev.(A)	0.042426407	0.000840043
	st.dev(2)a	2.03646753	0.035464234
	st.dev(2)b	1.159655121	0.037988605
	st.dev(2)c	0.272717361	0.029681514
	st.dev(A)2	1.220131177	0.032668333
	avst.dev(2)	1.156280004	0.034378117
	season SD	1.161989296	0.017233421
	median	5.42	0.118156
	average SD	1.210250062	0.032077829
	average SD (%)	23.02999862	26.76379287

Appendix 1. Mg-WS

sampling date		Mg	ash (%)	Tw (%)
24.7	WS0	6.18	0.131016	
31.7	WS00	5.92	0.108336	
6.6	WS1	7.641638884	0.116932	
12.6	WS2	6.5	0.1469	
16.6	WS3	2.98	0.063176	
21.6	WS4	4.98	0.097606	
26.6	WS5	4.96	0.106144	
3.7	WS6	6.74052846	0.147384	
9.7	WS7	4.56	0.096672	
13.7	WS8	3.95	0.083345	
18.7	WS9	6.040981722	0.113798	
24.7	WS10	6.12311781	0.121529	
31.7	WS11	4.147291063	0.09495	
WS	average	5.329414358	0.108039636	
	st.dev(5)	1.452975615	0.021761536	
	st.dev.(A)	0.042426407	0.000895197	
	st.dev2a	1.384540926	0.030083685	
	st.dev.2b	0.023875022	0.00254417	
	st.dev.2c	0.155443392	0.018299811	
	st.dev.double	0.023875022	0.00254417	
	av.st.dev(2)	0.521286447	0.016975889	
	season SD	1.396949977	0.025274274	
	median	4.98	0.106144	
	average SD	0.754208739	0.018172301	
	average SD (%)	14.15181272	16.82003128	

Appendix 1. Mn-DB

sampling date		Mn ash (ppm)	Tw (ppm)
13.7	DB0	12500	250
31.7	DB00	9225	195.7125
8.6	DB1	4896.754672	135.5173333
12.6	DB2	11761.81652	276.9
16.6	DB3	12601.29612	296.06
21.6	DB4	13200	306.52
26.6	DB5	16700	342.35
3.7	DB6	13448.4043	297.397
9.7	DB7	15600	326.04
13.7	DB8	10531.50018	204.18
18.7	DB9	8971.743492	212.6266667
24.7	DB10	10207.90317	210.9
31.7	DB11	7187.370293	151.652
DB	average	11373.34443	250.9220909
	st,dev(5)	4038.401206	75.79573352
	stdev(2)a	0	0
	stdev(2)b	935.8466217	53.65190801
	stdev(2)c	1689.238899	45.29160355
	stdev(A)0	0	
	stdevdouble(a)	592.4770801	6.17728484
	stdevdouble(b)	989.9494937	48.30953529
	stdevdouble(c)	989.9494937	25.02450899
	stdevdouble(d)	1378.858223	18.93278407
	avstdevdouble	987.8085727	24.6110283
	avstdev(2)	875.0285069	32.98117052
	season SD	3504.888491	70.98663921
	median	11761.81652	276.9
	average SD	1665.871682	43.68481127
	average SD (%)	14.64715758	17.40971116

Appendix 1. Mn-DS

sampling date	Mn	ash	Tw (ppm)	(ppm)
9.7	DS0	10400	211.89	
24.7	DS00	7860	171.348	
6.6	DS1	10479.40287		232.546
12.6	DS2	17100	415.53	
16.6	DS3	8560	179.76	
21.6	DS4	9995	218.14	
26.6	DS5	10200	230.52	
3.7	DS6	9513.738688		211.31
9.7	DS7	11100	247.53	
13.7	DS8	12500	250	
18.7	DS9	10805	218.102	
24.7	DS10	8375.739594		154.816
31.7	DS11	9210	206.13	
DS	average	10712.62556		233.1258182
	st.dev(5)	1118.264831		39.52986711
	st.dev(2)a		1986.970055	65.53465648
	st.dev(2)b		2397.091988	32.73621554
	stdev(2)c		1965.756852	59.2696904
	stdev(A)	424.2640687		9.545941546
	av.st.dev(2)		2116.606298	52.51352081
	season SD		2424.336239	66.63779907
	median	10200	218.14	
	average SD		1867.020932	49.26760738
	average SD (%)		17.42822916	21.13348396

Appendix 1. Mn-HB

sampling date	Mn	ash	Tw (ppm)	(ppm)
31.7	HB0	2870	66.297	
18.7	HB00	3590	75.32	
8.6	HB1	6361.036373		138.7256
12.6	HB2	5120	126.464	
16.6	HB3	5560	133.44	
21.6	HB4	7265	169.632	
26.6	HB5	3740	72.182	
3.7	HB6	8400	180.6	
9.7	HB7	3780	92.232	
13.7	HB8	3363.693467		67.32
18.7	HB9	4520	93.555	
24.7	HB10	2984.170743		59.04
31.7	HB11	4220.909391		116.8946667
HB	average	5028.619089		113.6441152
	stdev(5)	934.5286079		24.70145528
	stdev(A)	254.5584412		5.345727266
	stdev(2)a		1661.700936	57.3095904
	stdev(2)b		127.2792206	1.995455337
	stdev(2)c		119.1819034	12.13682682
	stdevdouble		494.9747468	9.379064346
	avrstdev(2)		636.0540199	23.81395752
	season SD		1718.024572	40.6476303
	median	4520	116.8946667	
	average SD		710.6726669	24.03583196
	average SD (%)		14.13256113	21.15008941

Appendix 1. Mn-WB

sampling date	Mn	ash	Tw (ppm)	(ppm)
24.7	WB0	1140	35.682	
31.7	WB00	5400	106.92	
6.6	WB1	4756.635139		104.551875
12.6	WB2	4680	111.384	
16.6	WB3	7310	169.592	
21.6	WB4	5215	116.193	
26.6	WB5	5450	122.625	
3.7	WB6	8690	199.87	
9.7	WB7	1470	44.688	
13.7	WB8	4830	105.294	
18.7	WB9	8595	173.953	
26.6	WB10	5916.348572		127.68
31.7	WB11	3928.19406		95.0645
WB	average	5531.016161		124.6268523
	st.dev(5)	943.2619059		13.36780121
	st.dev.(A)		14.14213562	0.280014285
	st.dev(2)a		445.4772721	1.475024746
	st.dev(2)b		3259.762261	82.33127096
	st.dev(2)c		123.8507072	23.42998319
	st.dev(A)2		410.4077595	10.98843938
	avst.dev(2)		1276.363414	35.7454263
	season SD		2089.571232	42.91528099
	median	5215	116.193	
	average SD		1193.088037	30.15102003
	average SD (%)		21.57086513	24.19303664

Appendix 1. Mn-WS

sampling date	Mn	ash (ppm)	Tw (ppm)
24.7	WS0	3790	80.348
31.7	WS00	4760	87.108
6.6	WS1	4424.533224	67.704
12.6	WS2	5190	117.294
16.6	WS3	4900	103.88
21.6	WS4	5345	105.076
26.6	WS5	5770	123.478
3.7	WS6	5715.039199	131.46575
9.7	WS7	3410	72.292
13.7	WS8	5350	112.885
18.7	WS9	4545.568483	92.865
24.7	WS10	4338.70249	85.977
31.7	WS11	3646.205142	73.64566667
WS	average	4785.004413	98.77840152
	st.dev(5)	1108.664433	32.45551291
	st.dev.(A)	84.85281374	1.79039437
	st.dev2a	996.2166045	15.81392029
	st.dev.2b	567.5203809	9.125920118
	st.dev.2c	346.8239848	5.973502853
	st.dev.double	567.5203809	9.125920118
	av.st.dev(2)	636.8536567	10.30444775
	season SD	788.6188467	21.87164587
	median	4900	103.88
	average SD	754.8063508	15.84221404
	average SD (%)	15.77441285	16.03813567

Appendix 1.	P-DB			
	P	ash	Tw	
sampling date			(ppm)	(ppm)
13.7	DB0	61600	1232	
31.7	DB00	41200	871.8	
8.6	DB1	35363.13909		928.2533333
12.6	DB2	27333.79896		643.5
16.6	DB3	38919.04731		914.38
21.6	DB4	33600	782	
26.6	DB5	44000	902	
3.7	DB6	28846.3419		647.702
9.7	DB7	45450	949.905	
13.7	DB8	25686.5858		498
18.7	DB9	33980.13271		770.6766667
24.7	DB10	25072.04288		518
31.7	DB11	28865.76856		596.33
DB	average	33374.25975		740.977
	st,dev(5)	16796.73855		365.4740622
	stdev(2)a		494.9747468	10.34497221
	stdev(2)b		7947.692539	190.1321689
	stdev(2)c		2794.024368	99.98489886
	stdev(A)	494.9747468		10.34497221
	stdevdouble(a)		13366.22333	245.5074744
	stdevdouble(b)		777.8174593	71.219795
	stdevdouble(c)		4949.747468	104.9912149
	stdevdouble(d)		10182.33765	170.2713129
	avstdevdouble		7319.031476	147.9974493
	avstdev(2)		3745.563885	100.1540133
	season SD		7065.345315	168.8687682
	median	33600	770.6766667	
	average SD		7008.357551	166.4840255
	average SD (%)		20.99928988	22.46817722

Appendix 1. P-DS

sampling date	P	ash (ppm)	Tw (ppm)
9.7	DS0	45100	915.16
24.7	DS00	41400	902.52
6.6	DS1	37157.43837	911.1088889
12.6	DS2	41700	1013.31
16.6	DS3	37700	791.7
21.6	DS4	34950	759.8
26.6	DS5	40100	906.26
3.7	DS6	21974.2106	488.07
9.7	DS7	50100	1117.23
13.7	DS8	41500	830
18.7	DS9	42700	863.59
24.7	DS10	32917.36641	608.44
31.7	DS11	30800	687.12
DS	average	37418.09231	816.0571717
	st.dev(5)	12597.97768	303.5553168
	st.dev(2)a	4313.351365	172.2512119
	st.dev(2)b	7212.489168	83.3678895
	stdev(2)c	3959.797975	140.1768483
	stdev(A)	1484.92424	33.41079541
	av.st.dev(2)	5161.879503	131.9319832
	season SD	7346.609545	178.9699171
	median	37700	830
	average SD	7020.904046	174.8378166
	average SD (%)	18.76339389	21.42470193

Appendix 1.		P-HB ash	Tw	
sampling date	P		(ppm)	(ppm)
31.7	HB0	46200	1067.22	
18.7	HB00	37600	790	
8.6	HB1	41221.97646		900.312
12.6	HB2	44000	1086.8	
16.6	HB3	28800	691.2	
21.6	HB4	33500	772.175	
26.6	HB5	43300	835.69	
3.7	HB6	37000	795.5	
9.7	HB7	43300	1056.52	
13.7	HB8	21675.13705		433.8
18.7	HB9	34700	718.57	
24.7	HB10	21107.54916		417.6
31.7	HB11	29075.9432		619.0866667
HB	average	34334.60053		757.0230606
	stdev(5)	11045.39114		261.2024401
	stdev(A)	424.2640687		8.909545443
	stdev(2)a		0	87.64588553
	stdev(2)b		3959.797975	86.87513914
	stdev(2)c		7400.670113	245.386246
	stdevdouble		2828.427125	70.03185561
	avrstdev(2)		3786.822696	139.9690902
	season SD		8384.803409	217.1175794
	median	34700	772.175	
	average SD		5601.464807	170.2774277
	average SD (%)		16.3143439	22.49303047

Appendix 1.	P	P-WB ash	Tw (ppm)	(ppm)
sampling date				
24.7	WB0	32500	1017.25	
31.7	WB00	43650	864.27	
6.6	WB1	30771.33227		851.395
12.6	WB2	43100	1025.78	
16.6	WB3	42600	988.32	
21.6	WB4	33950	750.56	
26.6	WB5	44000	990	
3.7	WB6	37300	857.9	
9.7	WB7	27500	836	
13.7	WB8	41300	900.34	
18.7	WB9	46100	909.43	
26.6	WB10	22775.71781		491.52
31.7	WB11	24389.90203		616.86
WB	average	35798.81383		838.0095455
	st.dev(5)	7168.529018		344.2592553
	st.dev.(A)		636.3961031	12.60064284
	st.dev(2)a		10111.62697	170.7804298
	st.dev(2)b		5515.432893	14.94823735
	st.dev(2)c		1279.497452	157.2534771
	st.dev(A)2		3161.248958	84.64068171
	avst.dev(2)		5635.519105	114.3273814
	season SD		8383.210877	163.4400287
	median	37300	857.9	
	average SD		6018.771584	171.8103499
	average SD (%)		16.81276819	20.50219485

Appendix 1. P-WS

sampling date	P	ash (ppm)	Tw (ppm)	
24.7	WS0	46500	985.8	
31.7	WS00	48500	887.55	
6.6	WS1	35898.68532		549.32
12.6	WS2	53200	1202.32	
16.6	WS3	26900	570.28	
21.6	WS4	34250	682.255	
26.6	WS5	42800	915.92	
3.7	WS6	40465.59482		933.1325
9.7	WS7	53500	1134.2	
13.7	WS8	37050	781.755	
18.7	WS9	40435.89033		851.02
24.7	WS10	32234.76045		638.57
31.7	WS11	21500.86724		574.7066667
WS	average	38021.4362		803.0435606
	st.dev(5)	5848.527033		151.0398523
	st.dev.(A)	353.5533906		7.459976542
	st.dev2a	14232.80038		216.9507852
	st.dev.2b	5042.010127		84.18813337
	st.dev.2c	941.0358745		237.658495
	st.dev.double	5042.010127		84.18813337
	av.st.dev(2)	6738.615461		179.5991378
	season SD	9769.276111		226.680196
	median	37050	781.755	
	average SD	6516.093354		172.4593165
	average SD (%)	17.1379464		21.47571127

Appendix 1. Zn-DB

sampling date		Zn ash	Tw (ppm)	CR (ppm)	(ppm)
13.7	DB0	1700	34	16.02790181	
31.7	DB00	1650	35.185	13.32330902	
8.6	DB1	1248.110791		28.88	16.7828527
12.6	DB2	1242.445407		29.25	14.16163399
16.6	DB3	2007.286108		47.16	19.8035631
21.6	DB4	1700	39.53	19.64334386	
26.6	DB5	1700	34.85	16.59536882	
3.7	DB6	1479.488464		33.107	14.53822674
9.7	DB7	2200	45.98	23.57906182	
13.7	DB8	1712.439054		33.2	16.42530217
18.7	DB9	1420.260709		25.42	12.46252358
24.7	DB10	1432.688165		29.6	16.6814025
31.7	DB11	1568.829015		34.11	15.26657696
DB	average	1610.140701		34.64427273	16.9036233
	st,dev(5)	283.958928		7.490663856	1.938650187
	stdev(2)a		0	0	0.223832152
	stdev(2)b		28.65296964	5.982674987	1.280838382
	stdev(2)c		351.2598735	9.560083682	6.234139321
	stdev(A)0		0	0.223832152	
	stdevdouble(a)		278.2556782	4.355777772	1.50736414
	stdevdouble(b)		70.71067812	1.301076477	0.128958267
	stdevdouble(c)		70.71067812	2.001112191	0.81649797
	stdevdouble(d)		70.71067812	3.372899346	2.136139128
	avstdevdouble		122.5969281	2.757716447	1.147239876
	avstdev(2)		126.6376144	5.180919556	2.579603285
	season SD		297.4657573	6.976003786	3.104542999
	median	1568.829015		33.2	16.59536882
	average SD		165.9679428	5.758355631	2.41936501
	average SD(%)		10.30766707	16.62137831	14.3127007

Appendix 1. Zn-DS

sampling date	Zn ash	Tw (ppm)	CR (ppm)	(ppm)
9.7	DS0 2050	41.655	24.21808983	
24.7	DS00 2200	47.96	21.12240419	
6.6	DS1 1813.307864		40.30333333	20.27599401
12.6	DS2 1900	46.17	18.41711362	
16.6	DS3 1700	35.7	16.37837149	
21.6	DS4 1600	34.56	15.91168071	
26.6	DS5 1800	40.68	18.98893247	
3.7	DS6 1768.039933		39.27	16.33087459
9.7	DS7 1900	42.37	19.38003841	
13.7	DS8 2100	42	22.93081237	
18.7	DS9 1700	34.175	15.49726762	
24.7	DS10 1242.16477		22.96	12.17169612
31.7	DS11 1550	34.35	17.43516824	
DS	average 1733.955688		37.50348485	17.6107227
	st.dev(5)209.258706		5.904049458	1.500249864
	st.dev(2)a	0	3.62038672	0.126879394
	st.dev(2)b	565.6854249	8.987327189	5.328470143
	stdev(2)c	70.71067812	1.060660172	1.890259752
	stdev(A)0	0	0	
	av.st.dev(2)	212.1320344	4.556124693	2.44853643
	season SD	222.9121634	6.200910975	2.84975785
	median 1768.039933		39.27	17.43516824
	average SD	211.4137023	4.893105885	2.211464788
	average SD(%)	12.19256661	13.0470699	12.55749027

Appendix 1. Zn-HB

	Zn	ash	Tw	CR	
sampling date			(ppm)	(ppm)	(ppm)
31.7	HB0	1900	43.89	15.22373845	
18.7	HB00	2450	51.42	19.24263926	
8.6	HB1	2016.474661		44.052	20.82443211
12.6	HB2	2300	56.81	27.04638207	
16.6	HB3	1400	33.6	18.81487537	
21.6	HB4	1950	44.855	22.71242094	
26.6	HB5	2000	38.6	16.32799542	
3.7	HB6	2100	45.15	22.05744243	
9.7	HB7	2400	58.56	27.79742855	
13.7	HB8	1259.136592		25.2	9.936815
18.7	HB9	2300	47.62	19.23965469	
24.7	HB10	909.8081534		18	7.9224424
31.7	HB11	1815.626745		48.14	19.2905772
HB	average	1859.186014		41.87154545	19.27004238
	stdev(5)	342.3987195		9.163671208	5.137985054
	stdev(A)	70.71067812		1.48492424	0.754686368
	stdev(2)a		70.71067812	3.471894296	2.238806254
	stdev(2)b		141.4213562	3.252691193	1.814258114
	stdev(2)c		390.8234685	14.09633995	1.64329354
	stdevdouble		212.1320344	781.4350176	1.160335965
	avrstdev(2)		200.9851676	6.94030848	1.898785969
	season SD		476.0301878	12.35037013	6.164128418
	median	2000	44.855	19.2905772	
	average SD		236.3385556	7.496149162	2.708585741
	average SD(%)		12.71193704	17.90272864	14.05594076

Appendix 1. Zn-WB

sampling date		Zn ash	Tw (ppm)	CR (ppm)	(ppm)
24.7	WB0	1800	56.34	28.00199565	
31.7	WB00	2100	41.58	14.70390521	
6.6	WB1	1796.93931		44.1375	18.69637985
12.6	WB2	1600	38.08	15.011829	
16.6	WB3	1400	32.48	10.33651584	
21.6	WB4	2100	46.82	21.62707505	
26.6	WB5	1800	40.5	17.31814657	
3.7	WB6	1900	43.7	23.97635186	
9.7	WB7	1700	51.68	30.19523988	
13.7	WB8	2200	47.96	17.75953966	
18.7	WB9	2100	41.54	18.30875392	
26.6	WB10	1601.417658		34.56	16.94483823
31.7	WB11	1544.652763		37.965	16.56621816
WB	average	1794.819067		41.76568182	18.79462619
	st.dev(5)	398.0741336		11.0254054	4.061564687
	st.dev.(A)		141.4213562	2.800142853	1.323974747
	st.dev(2)a		141.4213562	0.254558441	1.872001305
	st.dev(2)b		141.4213562	1.499066376	2.07961399
	st.dev(2)c		187.8905975	3.754737008	3.480540698
	st.dev(A)2		0	0	0
	avst.dev(2)		156.9111033	1.836120608	2.477385331
	season SD		257.7501237	5.82584394	5.12426447
	median	1796.93931		41.54	17.75953966
	average SD		217.2018609	4.133441807	2.87343017
	average SD(%)		12.10160205	9.896742079	15.28857313

Appendix 1. Zn-WS

sampling date	Zn	ash (ppm)	Tw (ppm)	CR (ppm)		
24.7	WS0	1700	36.04	18.16977762		
31.7	WS00	2700	49.41	21.5576563		
6.6	WS1	1944.849769		29.76	17.22653609	
12.6	WS2	2400	54.24	38.98217457		
16.6	WS3	1500	31.8	15.17721603		
21.6	WS4	2000	39.7	15.99644157		
26.6	WS5	2300	49.22	18.14725063		
3.7	WS6	2176.059083		49.45625	17.90780788	
9.7	WS7	1700	36.04	13.98067124		
13.7	WS8	2900	61.19	23.31324541		
18.7	WS9	2389.9315		51.09	19.9387699	
24.7	WS10	1934.287171		38.335	17.53755357	
31.7	WS11	1368.253934		31.98666667	14.02673367	
WS	average	2055.761951		42.98344697	19.29403642	
	st.dev(5)	177.822913		5.97784944	2.191911108	
	st.dev.(A)	141.4213562		2.983990617	1.136893374	
	st.dev2a	410.0250596		6.101663708	1.988378006	
	st.dev.2b	234.3533309		3.698168466	2.447394013	
	st.dev.2c	215.2105365		7.730215607	2.080462607	
	st.dev.double	234.3533309		3.698168466	2.447394013	
	av.st.dev(2)	286.5296423		5.84334926	2.172078208	
	season SD	442.1880646		10.51739172	7.061074371	
	median	2000		39.7	17.53755357	
	average SD	259.35296		5.876974305	2.177036433	
	average SD(%)	12.61590428		13.67264545	11.28346804	

Appendix 3. Ag-DB

sampling date	Ag	ash	Tw (ppm)	Cr (ppm)	(ppm)
13.7	DB0	1.4	0.028	0.008621344	
31.7	DB00	1.2	0.02556	0.006078019	
8.6	DB1	2.413014197		0.049313333	0.019813133
12.6	DB2	1.656593877		0.039	0.010613722
16.6	DB3	1.561222528		0.03668	0.011009823
21.6	DB4	1.3	0.03005	0.010325381	
26.6	DB5	1.2	0.0246	0.007823175	
3.7	DB6	1.288555025		0.02846	0.008120647
9.7	DB7	1.7	0.03553	0.013063331	
13.7	DB8	1.369951243		0.02656	0.007838179
18.7	DB9	0.850162943		0.01974	0.004144614
24.7	DB10	1.074516124		0.0222	0.008530875
31.7	DB11	1.020592154		0.0216	0.006560316
DB	average	1.40314619		0.030339394	0.009803927
	st,dev(5)	0.238515178		0.003560225	0.002120253
	stdev(2)a		0.141421356	0.002955706	0.000863107
	stdev(2)b		0.070941115	0.00433622	0.000425599
	stdev(2)c		0.190290757	0.005374012	0.003138482
	stdev(A)	0.141421356		0.002955706	0.000863107
	stdevdouble(a)		0.097738801	0.001131371	0.000329833
	stdevdouble(b)		0	0.001979899	0.000273234
	stdevdouble(c)		0	0.000254558	0.000108148
	stdevdouble(d)		0	0.001357645	0.000932545
	avstdevdouble		0.0244347	0.001180868	0.00041094
	avstdev(2)		0.134217743	0.004221979	0.001475729
	season SD		0.42701941	0.008988751	0.004098539
	median	1.3	0.02846	0.008530875	
	average SD		0.160292101	0.004056541	0.00163686
	average SD(%)		11.42376344	13.37053912	16.69596474

Appendix 3. Ag-DS

sampling date	Ag	ash	Tw (ppm)	CR (ppm)	(ppm)
9.7	DS0	1.015	0.0206365		0.008873542
24.7	DS00	0.8	0.01744	0.005133057	
6.6	DS1	1.273511988		0.027742222	0.010149868
12.6	DS2	1.4	0.03402	0.008804864	
16.6	DS3	1	0.021	0.006614575	
21.6	DS4	1	0.0216	0.006313792	
26.6	DS5	1.4	0.03164	0.009545443	
3.7	DS6	0.884019967		0.019635	0.004838511
9.7	DS7	1.2	0.02676	0.007893096	
13.7	DS8	2.2	0.044	0.016429911	
18.7	DS9	1	0.02035	0.006173069	
24.7	DS10	1.304273009		0.024108	0.008260784
31.7	DS11	1.4	0.03084	0.011108522	
DS	average	1.278345906		0.027426838	0.008739312
	st.dev(5)	0.353987802		0.008858721	0.002086751
	st.dev(2)a	0		0.002262742	0.000305297
	st.dev(2)b	0		0.001484924	4.40249E-05
	stdev(2)c	0.282842712		0.003903229	0.003218842
	stdev(A)	0.141421356		0.003181981	0.00111153
	av.st.dev(2)	0.094280904		0.002550298	0.001189388
	season SD	0.358970941		0.007383423	0.003170912
	median	1.273511988	0.02676	0.008260784	
	average SD	0.159207629		0.004127404	0.001413729
	average SD(%)	12.45419004		15.04877861	16.17665939

Appendix 3. Ag--HB

sampling date	Ag	ash	Tw (ppm)	CR (ppm)	(ppm)
31.7	HB0	1.2	0.02772	0.005985914	
18.7	HB00	0.6	0.01256	0.002760774	
8.6	HB1	0.851132762	0.01832	0.005608978	
12.6	HB2	0.6	0.01482	0.005207793	
16.6	HB3	0.8	0.0192	0.008710469	
21.6	HB4	0.8	0.01844	0.006765203	
26.6	HB5	0.8	0.01544	0.003497864	
3.7	HB6	1	0.0215	0.007095684	
9.7	HB7	0.4	0.00976	0.003118226	
13.7	HB8	0.719506624	0.0144	0.003221786	
18.7	HB9	0.6	0.01242	0.002826605	
24.7	HB10	0.545884892	0.0108	0.00224501	
31.7	HB11	0.654358864	0.02078	0.006153112	
HB	average	0.706443922	0.015989091	0.004950066	
	stdev(5)	0.273058922	0.005013841	0.003030384	
	stdev(A)	0.141421356	0.002969848	0.001110528	
	stdev(2)a	0	0.002093036	0.000993588	
	stdev(2)b	0	8.48528E-05	0.000189764	
	stdev(2)c	0.084977603	0.003353625	3.74142E-05	
	stdevdouble	0.282842712	0.226805914	0.001118107	
	avrstdev(2)	0.028325868	0.001843838	0.000406922	
	season SD	0.166912982	0.003971563	0.002103921	
	median	0.719506624	0.01544	0.005207793	
	average SD	0.089509131	0.002636339	0.001062788	
	average SD(%)	12.67038028	16.48835868	21.47016975	

Appendix 3. Ag-WB

sampling date	Ag	ash	Tw (ppm)	CR (ppm)	(ppm)
24.7	WB0	0.4	0.01252	0.004913575	
31.7	WB00	1	0.0198	0.004036091	
6.6	WB1	0.895364142	0.0187425		0.005552315
12.6	WB2	1.2	0.02856	0.00738757 2	
16.6	WB3	1	0.0232	0.004422832	
21.6	WB4	0.8	0.01765	0.00545402	
26.6	WB5	0.6	0.0135	0.003122557	
3.7	WB6	1	0.023	0.009686632	
9.7	WB7	0.6	0.01824	0.009024101	
13.7	WB8	0.4	0.00872	0.002016935	
18.7	WB9	1	0.02043	0.005364398	
26.6	WB10	0.889676477	0.0192	0.005872279	
31.7	WB11	0.823758327	0.01908	0.005928785	
WB	average	0.837163541	0.019120227		0.005802948
	st.dev(5)	0.226653304	0.004708284		0.001916106
	st.dev.(A)	0	0	5.05998E-05	
	st.dev(2)a	0.282842712	0.005020458		0.001010381
	st.dev(2)b	0.565685425	0.013279465		0.002790576
	st.dev(2)c	0.166081994	0.00814587		0.00338149
	st.dev(A)2	0	0	0	
	avst.dev(2)	0.338203377	0.008815265		0.002394149
	season SD	0.22858439	0.005151317		0.002275753
	median	0.889676477	0.01908	0.005552315	
	average SD	0.310315859	0.007788519		0.002274638
	average SD(%)	37.06753148	40.73444958		39.19797691

Appendix 3. Ag-WS

sampling date	Ag	ash (ppm)	Tw (ppm)	CR (ppm)		
24.7	WS0	0.6	0.01272	0.004014011		
31.7	WS00	0.8	0.01464	0.003601218		
6.6	WS1	1.021046129		0.015624	0.004907102	
12.6	WS2	0.6	0.01356	0.008961888		
16.6	WS3	0.8	0.01696	0.004870483		
21.6	WS4	0.8	0.01588	0.00384216		
26.6	WS5	0.8	0.01712	0.004017917		
3.7	WS6	0.735356084		0.0166265	0.003578611	
9.7	WS7	1	0.0212	0.00494989		
13.7	WS8	0.6	0.01266	0.002900262		
18.7	WS9	0.697016741		0.013806667	0.003126596	
24.7	WS10	0.586229795		0.011631	0.003318276	
31.7	WS11	0.726498857		0.015873333	0.004607718	
WS	average	0.760558873		0.015540136	0.0044619	
	st.dev(5)	0.104882007		0.002151364	0.000753292	
	st.dev.(A)	0		0	0	
	st.dev2a	0.137202391		0.002247695	0.000279737	
	st.dev.2b		0.019474011	9.75807E-05	0.000249355	
	st.dev.2c	0.34840965		0.005484317	0.002350975	
	st.dev.double		0.019474011	9.75807E-05	0.000249355	
	av.st.dev(2)		0.168362017	0.002609864	0.000960022	
	season SD		0.147524327	0.002616528	0.001666297	
	median	0.735356084		0.015873333	0.004017917	
	average SD		0.152492015	0.002495239	0.00090834	
	average SD(%)		20.04999483	16.05673937	20.35768531	

Appendix 3. Co-DB

sampling date	Co	ash	Tw (ppm)	CR (ppm)	(ppm)
13.7	DB0	11	0.22	0.096622462	
31.7	DB00	6.5	0.13805	0.051041962	
8.6	DB1	11.64903405	0.248133333	0.154494403	
12.6	DB2	9.111266321	0.2145	0.100472773	
16.6	DB3	12.26674844	0.2882	0.116657365	
21.6	DB4	11.5	0.26995	0.124317145	
26.6	DB5	9	0.1845	0.082000258	
3.7	DB6	11.81477196	0.26145	0.115338103	
9.7	DB7	22	0.4598	0.224168863	
13.7	DB8	5.137317161	0.0996	0.04625999	
18.7	DB9	9.852118262	0.180766667	0.083593089	
24.7	DB10	10.74516124	0.222	0.114617326	
31.7	DB11	5.102960769	0.1142	0.047512193	
DB	average	10.74357984	0.231190909	0.109948319	
	st,dev(5)	3.559620607	0.072942769	0.04342341	
	stdev(2)a	0	0	0.002354447	
	stdev(2)b	2.619290765	0.044350235	0.026665384	
	stdev(2)c	2.012113957	0.049356053	0.026839126	
	stdev(A)	0	0	0.002354447	
	stdevdouble(a)	0.218412774	0.008202439	0.004158528	
	stdevdouble(b)	1.414213562	0.015556349	0.007421187	
	stdevdouble(c)	0.707106781	0.017889802	0.005956244	
	stdevdouble(d)	0.707106781	0.007707464	0.000334707	
	avstdevdouble	0.761709975	0.012339013	0.004467666	
	avstdev(2)	1.543801574	0.031235429	0.018619652	
	season SD	4.486786131	0.097111185	0.049852745	
	median	10.74516124	0.222	0.114617326	
	average SD	2.047756332	0.041662264	0.024820592	
	average SD(%)	19.06027938	18.02071906	22.57478057	

Appendix 3. Co-DS

sampling date	Co	ash	Tw (ppm)	CR (ppm)	(ppm)
9.7	DS0	15.5	0.3148	0.170387298	
24.7	DS00	10	0.218	0.091985705	
6.6	DS1	14.80671614		0.323033333	0.155381419
12.6	DS2	18	0.4374	0.174378484	
16.6	DS3	16	0.336	0.147597564	
21.6	DS4	7.5	0.1628	0.070473688	
26.6	DS5	10	0.226	0.099767736	
3.7	DS6	14.31270422		0.3179	0.125292087
9.7	DS7	15	0.3345	0.147143172	
13.7	DS8	14	0.28	0.144175859	
18.7	DS9	13.5	0.2784	0.11766678	
24.7	DS10	15.08342935		0.2788	0.140132994
31.7	DS11	12.5	0.2769	0.131738997	
DS	average	13.70025907		0.295612121	0.13215898
	st.dev(5)	6.691876237		0.165706638	0.064970036
	st.dev(2)a		0.707106781	0.032244069	0.004880109
	st.dev(2)b		4.949747468	0.120773838	0.043101229
	stdev(2)c		0.707106781	0.005515433	0.015467364
	stdev(A)	1.414213562		0.031819805	0.014398712
	av.st.dev(2)		2.121320344	0.052844447	0.021149567
	season SD		2.875484361	0.069392807	0.028467976
	median	14.31270422		0.28	0.140132994
	average SD		3.263959317	0.081059995	0.032104684
	average SD(%)		23.82407005	27.42106594	24.29247294

Appendix 3. Co-HB

sampling date	Co	ash	Tw (ppm)	CR (ppm)	(ppm)
31.7	HB0	3	0.0693	0.023316149	
18.7	HB00	4.5	0.0944	0.034746257	
8.6	HB1	3.398858936		0.07466	0.033427941
12.6	HB2	4	0.0988	0.045638146	
16.6	HB3	4	0.096	0.051790215	
21.6	HB4	4.5	0.1028	0.049654485	
26.6	HB5	4	0.0772	0.032876303	
3.7	HB6	5	0.1075	0.048740957	
9.7	HB7	5	0.122	0.056013615	
13.7	HB8	2.69814984		0.054	0.020481404
18.7	HB9	4	0.0829	0.03288575	
24.7	HB10	2.72942446		0.054	0.023640213
31.7	HB11	3.646200958		0.068866667	0.027694441
HB	average	3.906603109		0.085338788	0.038440315
	stdev(5)	1.08557794		0.027625676	0.014284697
	stdev(A)	0	0	0	
	stdev(2)a		0.707106781	0.004525483	0.000494537
	stdev(2)b		1.414213562	0.029839906	0.012208613
	stdev(2)c		0.649866275	0.017709131	0.008998203
	stdevdouble		0.707106781	0.860294394	0.004184693
	avrstdev(2)		0.923728873	0.017358174	0.007233784
	season SD		0.771347367	0.022037962	0.012307254
	median	4	0.0829	0.033427941	
	average SD		0.96419114	0.019925049	0.008996513
	avera[illegible] SD(%)		24.68106211	23.34817478	23.403847

Appendix 3. Co-WB

sampling date	Co ash	Tw (ppm)	CR (ppm)	
24.7	WB0	2	0.0626	0.029387709
31.7	WB00	7	0.1386	0.048409252
6.6	WB1	3.72204682	0.0781875	0.036963789
12.6	WB2	3	0.0714	0.027689803
16.6	WB3	4	0.0928	0.029008455
21.6	WB4	3.5	0.07765	0.033516855
26.6	WB5	3	0.0675	0.029111817
3.7	WB6	9	0.207	0.107390333
9.7	WB7	3	0.0912	0.05113307
13.7	WB8	3	0.0654	0.023382031
18.7	WB9	4.5	0.09005	0.036592661
26.6	WB10	2.669029431	0.0576	0.02631816
31.7	WB11	2.696928714	0.06455	0.027706998
WB	average	3.82618227	0.087576136	0.038983088
	st.dev(5)	2.220141136	0.039217286	0.020806048
	st.dev.(A)	0	0	0.001168855
	st.dev(2)a	0.707106781	0.010111627	0.002713957
	st.dev(2)b	0.707106781	0.023263813	0.004795604
	st.dev(2)c	0.068202399	0.015697771	0.008981121
	st.dev(A)2	0.55460508	0.014849242	0.006880676
	avst.dev(2)	0.494138654	0.016357737	0.005496894
	season SD	1.80871216	0.041328618	0.02392125
	median	3	0.07765	0.029111817
	average SD	0.925639274	0.022072624	0.009324183
	average SD(%)	24.19224201	25.20392554	23.91853247

Appendix 3. Co-WS

sampling date	Co	ash (ppm)	Tw (ppm)	CR (ppm)	
24.7	WS0	4	0.0848	0.041081887	
31.7	WS00	4	0.0732	0.03119541	
6.6	WS1	4.862124422	0.0744	0.042024333	
12.6	WS2	4	0.0904	0.06505643	
16.6	WS3	4	0.0848	0.039368674	
21.6	WS4	4	0.0794	0.030701794	
26.6	WS5	4	0.0856	0.030895076	
3.7	WS6	5.168771084	0.1118375	0.041026423	
9.7	WS7	5	0.106	0.039855724	
13.7	WS8	4	0.0844	0.031484778	
18.7	WS9	4.48135463	0.082866667	0.036774412	
24.7	WS10	4.327071501	0.086	0.036745925	
31.7	WS11	3.221889575	0.0736	0.031001923	
WS	average	4.278291928	0.08720947	0.038630499	
	st.dev(5)	1.124503861	0.016963738	0.010650379	
	st.dev.(A)	0	0	0	
	st.dev2a	0.680738246	0.020223831	0.002401849	
	st.dev.2b	0.462548953	0.011313708	0.003298038	
	st.dev.2c	0.029674024	0.013908271	0.000366149	
	st.dev.double	0.462548953	0.011313708	0.003298038	
	av.st.dev(2)	0.390987074	0.015148603	0.002022012	
	season SD	0.565818688	0.011902534	0.009780536	
	median	4	0.0848	0.036774412	
	average SD	0.574366271	0.015602387	0.004179104	
	average SD(%)	13.42513041	17.89070271	10.81814632	

Appendix 3. Ni-DB

sampling date		Ni ash	Tw (ppm)	(ppm)
13.7	DB0	132	2.64	
31.7	DB00	77	1.6377	
8.6	DB1	154.7657381		3.4614
12.6	DB2	86.14288158		2.028
16.6	DB3	129.3584381		3.0392
21.6	DB4	129	3.0273	
26.6	DB5	86	1.763	
3.7	DB6	98.0365637		2.18106
9.7	DB7	128	2.6752	
13.7	DB8	82.19707458		1.5936
18.7	DB9	69.71075425		1.4438
24.7	DB10	66.26182762		1.369
31.7	DB11	68.38456451		1.4878
DB	average	99.8052584		2.188123636
	st,dev(5)	12.0089052		0.259276644
	stdev(2)a		2.828427125	0.059114127
	stdev(2)b		14.55119088	0.258164831
	stdev(2)c		16.56267049	0.44208316
	stdev(A)	2.828427125		0.059114127
	stdevdouble(a)		7.669496854	0.10012632
	stdevdouble(b)		1.90735E-06	0.170271313
	stdevdouble(c)		1.414213562	0.009475231
	stdevdouble(d)		4.242640687	0.003252691
	avstdevdouble		3.331588253	0.070781389
	avstdev(2)		11.31409617	0.253120706
	season SD		30.41355652	0.745810724
	median	86.14288158	2.028	
	average SD		11.48779842	0.25465969
	average SD (%)		11.5102136	11.63826788

Appendix 3. Ni-DS

sampling date	Ni	ash	Tw (ppm)	(ppm)
9.7	DS0	107.5	2.19575	
24.7	DS00	122	2.6596	
6.6	DS1	87.51489807		2.140511111
12.6	DS2	102	2.4786	
16.6	DS3	112	2.352	
21.6	DS4	112	2.4192	
26.6	DS5	110	2.486	
3.7	DS6	79.1408351		1.7578
9.7	DS7	90	2.007	
13.7	DS8	176	3.52	
18.7	DS9	121	2.5075	
24.7	DS10	117.1183926		2.1648
31.7	DS11	96	2.112	
DS	average	109.3431023		2.358673737
	st.dev(5)	17.6023368		0.63284401
	st.dev(2)a		0	0.25342707
	st.dev(2)b		60.81118318	1.417183411
	stdev(2)c		22.627417	0.339411255
	stdev(A)	4.242640687		0.095459415
	av.st.dev(2)		27.81286673	0.670007245
	season SD		25.785253	0.451207685
	median	110	2.352	
	average SD		25.26023424	0.660716437
	average SD (%)		23.10180862	28.01220135

Appendix 3. Ni_HB

sampling date	Ni	ash	Tw (ppm)	(ppm)
31.7	HB0	48	1.1088	
18.7	HB00	67	1.4052	
8.6	HB1	41.28399695		0.89884
12.6	HB2	56	1.3832	
16.6	HB3	56	1.344	
21.6	HB4	47	1.063	
26.6	HB5	48	0.9264	
3.7	HB6	52	1.118	
9.7	HB7	48	1.1712	
13.7	HB8	23.38396528		0.468
18.7	HB9	45	0.9318	
24.7	HB10	21.83539568		0.432
31.7	HB11	35.2798034		0.692133333
HB	average	43.07119648		0.948052121
	stdev(5)	8.531366898		0.201676989
	stdev(A)	2.828427125		0.05939697
	stdev(2)a		15.55634919	0.235607979
	stdev(2)b		4.242640687	0.094186623
	stdev(2)c		3.422889297	0.289170492
	stdevdouble		12.72792206	0.248335902
	avrstdev(2)		7.74062639	0.206321698
	season SD		11.76528639	0.31676927
	median	47	0.9318	
	average SD		7.938311517	0.205160521
	average SD (%)		18.43067332	21.64021538

Appendix 3. Ni-WB

sampling date		Ni ash	Tw (ppm)	(ppm)
24.7	WB0	20	0.626	
31.7	WB00	36	0.7128	
6.6	WB1	24.39840471		0.576325
12.6	WB2	30	0.714	
16.6	WB3	22	0.5104	
21.6	WB4	40	0.8894	
26.6	WB5	26	0.585	
3.7	WB6	78	1.794	
9.7	WB7	14	0.4256	
13.7	WB8	22	0.4796	
18.7	WB9	51	1.0283	
26.6	WB10	12.45547068		0.2688
31.7	WB11	17.55520883		0.4721
WB	average	30.67355311		0.703956818
	st.dev(5)	16.43340213		0.311020108
	st.dev.(A)	0	0	
	st.dev(2)a		5.656854249	0.061376869
	st.dev(2)b		15.55634919	0.413374624
	st.dev(2)c		2.642611196	0.030971277
	st.dev(A)2	0	0	
	avst.dev(2)		7.951938211	0.168574257
	season SD		19.32374393	0.420324287
	median	24.39840471	0.576325	
	average SD		10.07230419	0.20418572
	average SD (%)		32.83709635	29.00543248

Appendix 3. Ni-WS

sampling date	Ni	ash (ppm)	Tw (ppm)	
24.7	WS0	54	1.1448	
31.7	WS00	60	1.098	
6.6	WS1	25.93133025		0.3968
12.6	WS2	48	1.0848	
16.6	WS3	14	0.2968	
21.6	WS4	30	0.5926	
26.6	WS5	30	0.642	
3.7	WS6	34.6447778		0.7604375
9.7	WS7	22	0.4664	
13.7	WS8	24	0.5064	
18.7	WS9	35.88812778		0.7198
24.7	WS10	26.30828601		0.5195
31.7	WS11	32.23987845		0.930933333
WS	average	29.36476366		0.628770076
	st.dev(5)	16.43659445		0.292141394
	st.dev.(A)	0		0
	st.dev2a	8.643492587		0.142454624
	st.dev.2b	10.87772625		0.202939646
	st.dev.2c	4.853180171		0.480428531
	st.dev.double	10.87772625		0.202939646
	av.st.dev(2)	8.124799669		0.275274267
	season SD	8.757882812		0.233166177
	median	30	0.5926	
	average SD	10.20274836		0.279491049
	average SD (%)	34.74486797		44.45043739

Appendix 3. Rb-DB

sampling date	Rb	ash	Tw (ppm)	CR (ppm)	(ppm)
13.7	DB0	320	6.4	4.922447319	
31.7	DB00	180	3.818	1.757105383	
8.6	DB1	91.5281247		2.064333333	1.448075637
12.6	DB2	124.2445407		2.925	1.912177173
16.6	DB3	122.6674844		2.882	1.636016822
21.6	DB4	170	3.961	3.365935076	
26.6	DB5	140	2.87	2.207205778	
3.7	DB6	186.6057365		4.2299	2.48648479
9.7	DB7	125	2.6125	1.958023205	
13.7	DB8	188.3682959		3.652	2.859222473
18.7	DB9	197.0423652		3.684	2.510459398
24.7	DB10	62.68010721		1.295	1.281231675
31.7	DB11	259.402862		5.415	3.751931368
DB	average	151.5945015		3.235521212	2.310614854
	st,dev(5)	66.15752327		1.793573333	0.683388425
	stdev(2)a		7.071067812	0.147785317	0.117293491
	stdev(2)b		52.3858153	0.806391964	1.234446726
	stdev(2)c		31.18644471	0.311126984	0.350752011
	stdev(A)	7.071067812		0.147785317	0.117293491
	stdevdouble(a)		107.3327381	1.923330445	0.956779115
	stdevdouble(b)		42.42640687	0.526087445	0.469593737
	stdevdouble(c)		14.14213562	0.270821897	0.068442412
	stdevdouble(d)		28.28427125	0.398808225	0.045062562
	avstdevdouble		48.04638795	0.779762003	0.384969456
	avstdev(2)		30.21444261	0.421768088	0.567497409
	season SD		55.26775155	1.118941005	0.782009302
	median	140	2.925	2.207205778	
	average SD		39.20021277	0.764719399	0.596470163
	average SD(%)		25.85859802	23.63512242	25.81434817

Appendix 3. Rb-DS

sampling date	Rb	ash	Tw (ppm)	CR (ppm)	(ppm)
9.7	DS0	155	3.1355	2.959135098	
24.7	DS00	180	3.924	2.435116624	
6.6	DS1	142.1126639		3.236	2.302133621
12.6	DS2	51	1.2393	0.52823266	
16.6	DS3	120	2.52	1.630758069	
21.6	DS4	175	3.788	2.641936939	
26.6	DS5	230	5.198	3.677989937	
3.7	DS6	151.54628		3.366	2.112110134
9.7	DS7	360	8.028	5.078385947	
13.7	DS8	110	2.2	1.838556735	
18.7	DS9	145	2.9245	1.873965933	
24.7	DS10	363.7768256		6.724	5.331754702
31.7	DS11	220	5.004	3.819764797	
DS	average	188.0396154		4.020709091	2.803235407
	st.dev(5)	45.36831061		1.070759894	0.780412395
	st.dev(2)a		7.071067812	0.548714862	0.30903312
	st.dev(2)b		35.35533906	0.504167135	0.594876251
	stdev(2)c		141.4213562	3.512906489	2.237926519
	stdev(A)	21.21320344		0.477297077	0.270009359
	av.st.dev(2)		61.2825877	1.521929495	1.04727863
	season SD		99.09540679	2.032796675	1.498916573
	median	151.54628		3.366	2.302133621
	average SD		57.30401843	1.409137095	0.980562071
	average SD(%)		30.47443929	35.0469796	34.9796549

Appendix 3. Rb-HB

sampling date		Rb ash	Tw (ppm)	CR (ppm)	(ppm)
31.7	HB0	250	5.775	2.640559245	
18.7	HB00	180	3.782	1.69443282	
8.6	HB1	131.0064763		2.81832	2.07953909
12.6	HB2	210	5.187	3.197999814	
16.6	HB3	140	3.36	2.519002719	
21.6	HB4	150	3.439	2.471257801	
26.6	HB5	200	3.86	1.678901947	
3.7	HB6	95	2.0425	1.653647252	
9.7	HB7	150	3.66	2.314157789	
13.7	HB8	107.9259936		2.16	1.188800971
18.7	HB9	160	3.31	1.641570181	
24.7	HB10	191.0597122		3.78	1.897218501
31.7	HB11	146.849788		2.851333333	1.956019456
HB	average	152.8947246		3.315286667	2.054374138
	stdev(5)	50.73570781		1.025471215	0.676609318
	stdev(A)	21.21320344		0.445477272	0.322549312
	stdev(2)a		14.14213562	0.066468037	0.079805144
	stdev(2)b		28.28427125	0.562856998	0.091021193
	stdev(2)c		22.12297434	0.526613077	0.123583527
	stdevdouble		14.14213562	111.2519383	0.046886416
	avrstdev(2)		21.5164604	0.385312704	0.098136621
	season SD		36.13810458	0.87000248	0.54965709
	median	150	3.36	1.956019456	
	average SD		28.82127225	0.545352332	0.242754795
	average SD(%)		18.85040333	16.44962824	11.81648419

Appendix 3. Rb-WB

sampling date	Rb	ash	Tw (ppm)	CR (ppm)	(ppm)
24.7	WB0	110	3.443	2.566232658	
31.7	WB00	101	1.9998	0.829659901	
6.6	WB1	47.28033275		1.023825	0.738877663
12.6	WB2	45	1.071	0.505655868	
16.6	WB3	42	0.9744	0.37849429	
21.6	WB4	54	1.19425	0.847324952	
26.6	WB5	62	1.395	0.603575581	
3.7	WB6	110	2.53	2.075296731	
9.7	WB7	53	1.6112	1.283979725	
13.7	WB8	52	1.1336	0.5688808	
18.7	WB9	80.5	1.5972	1.121645135	
26.6	WB10	48.93220623		1.056	0.846484861
31.7	WB11	57.22269151		1.33455	1.034168095
WB	average	59.26683914		1.356456818	0.909489427
	st.dev(5)	18.78669654		0.301551463	0.406547322
	st.dev.(A)		12.72792206	0.252012857	0.116087183
	st.dev(2)a		15.55634919	0.259861742	0.016017764
	st.dev(2)b		0.707106781	0.151038008	0.170844024
	st.dev(2)c		7.257101371	0.46711474	0.585930069
	st.dev(A)2		0.55460508	0.014849242	0.012883425
	avst.dev(2)		7.840185779	0.292671497	0.257597286
	season SD		19.76951356	0.447924983	0.474497812
	median	53	1.19425	0.846484861	
	average SD		10.57681347	0.294891488	0.294834795
	average SD(%)		17.84609003	21.73983605	32.41761652

Appendix 3. Rb-WS

sampling date	Rb	ash (ppm)	Tw (ppm)	CR (ppm)	
24.7	WS0	52	1.1024	0.774221997	
31.7	WS00	100	1.83	1.015994626	
6.6	WS1	56.72478493	0.868	0.645326663	
12.6	WS2	47	1.0622	0.766130879	
16.6	WS3	33	0.6996	0.433824387	
21.6	WS4	52	1.0235	0.581812838	
26.6	WS5	42	0.8988	0.411385845	
3.7	WS6	61.58929532	1.2983875	0.719640633	
9.7	WS7	63	1.3356	0.688065014	
13.7	WS8	57.5	1.21325	0.576021833	
18.7	WS9	71.29117185	1.412566667	0.724922901	
24.7	WS10	54.56320082	1.08215	0.781080077	
31.7	WS11	58.43609111	1.421366667	0.954057648	
WS	average	54.28223127	1.119583712	0.662024429	
	st.dev(5)	15.75488378	0.335556461	0.2723261	
	st.dev.(A)	9.192388155	0.19395939	0.09208724	
	st.dev2a	22.21563781	0.363462878	0.206202344	
	st.dev.2b	3.446154456	0.041507168	0.067571235	
	st.dev.2c	9.081166556	0.424044341	0.184997019	
	st.dev.double	3.446154456	0.041507168	0.067571235	
	av.st.dev(2)	11.58098628	0.276338129	0.152923532	
	season SD	10.5564027	0.23804864	0.157243085	
	median	56.72478493	1.08215	0.688065014	
	average SD	12.62446065	0.291142712	0.182774174	
	average SD(%)	23.2570776	26.00455051	27.60837309	

Appendix 7. Ce-DB

sampling date	Ce	ash	Tw (ppm)	CR (ppm)	(ppm)
13.7	DB0	5	0.1	0.037733978	
31.7	DB00	13	0.2801	0.089558852	
8.6	DB1	3.744332374	0.0954	0.042105742	
12.6	DB2	4.141484691	0.0975	0.037464224	
16.6	DB3	7.806112642	0.1834	0.065691763	
21.6	DB4	8.5	0.20165	0.082645331	
26.6	DB5	6	0.123	0.047317524	
3.7	DB6	5.624541476	0.1247	0.046527392	
9.7	DB7	8	0.1672	0.072269131	
13.7	DB8	9.418414795	0.1826	0.070769267	
18.7	DB9	4.300651773	0.086066667	0.029484511	
24.7	DB10	5.372580618	0.111	0.049981519	
31.7	DB11	6.344145077	0.156	0.050640711	
DB	average	6.295660313	0.138956061	0.054081556	
	st,dev(5)	1.111828177	0.023137848	0.01372476	
	stdev(2)a	0	0	0.000948558	
	stdev(2)b	0.989027748	0.017392335	0.005738354	
	stdev(2)c	1.756299367	0.045254834	0.024420261	
	stdev(A)0	0	0.000948558		
	stdevdouble(a)	0.730041952	0.01979899	0.007314407	
	stdevdouble(b)	2.121320344	0.042143564	0.014226607	
	stdevdouble(c)	5.656854249	0.129541962	0.036787587	
	stdevdouble(d)	5.656854249	0.135198817	0.048934752	
	avstdevdouble	3.541267699	0.081670833	0.026815838	
	avstdev(2)	0.915109038	0.02088239	0.010369058	
	season SD	1.905754375	0.040683165	0.016480265	
	median 6	0.1247	0.049981519		
	average SD	0.964288823	0.021446254	0.011207983	
	average SD(%)	15.31672255	15.43383874	20.72422444	

Appendix 7. Ce-DS

sampling date	Ce	ash	Tw (ppm)	CR (ppm)	(ppm)
9.7	DS0	17	0.3497	0.171531364	
24.7	DS00	17	0.3706	0.135313209	
6.6	DS1	8.0830662		0.185077778	0.07654184
12.6	DS2	6	0.1458	0.049793479	
16.6	DS3	15	0.315	0.120814472	
21.6	DS4	7	0.1496	0.056087823	
26.6	DS5	7	0.1582	0.059783938	
3.7	DS6	8.419237777		0.187	0.061383967
9.7	DS7	6	0.1338	0.050340459	
13.7	DS8	10	0.2	0.089837149	
18.7	DS9	7.5	0.1563	0.056870073	
24.7	DS10	5.323563301		0.0984	0.042339148
31.7	DS11	10	0.2172	0.09438342	

DS				
	average	8.21144248	0.176943434	0.06892507
	st.dev(5)	1.912000147	0.04556204	0.017749104
	st.dev(2)a	1.414213562	0.014707821	0.011711548
	st.dev(2)b	4.949747468	0.111864293	0.037571421
	stdev(2)c	5.656854249	0.108611602	0.058880961
	stdev(A)0	0	0	
	av.st.dev(2)	4.006938427	0.078394572	0.036054643
	season SD	2.722208415	0.056484144	0.023884579
	median	7.5	0.1582	0.059783938
	average SD	3.483203857	0.070186439	0.031478259
	average SD(%)	42.41890344	39.66603169	45.67025989

Appendix 7. Ce-HB

sampling date	Ce	ash	Tw (ppm)	CR (ppm)	(ppm)
31.7	HB0	9	0.2079	0.059165974	
18.7	HB00	14	0.2932	0.089554719	
8.6	HB1	5.777280023		0.12936	0.050209275
12.6	HB2	8	0.1976	0.081643754	
16.6	HB3	8	0.192	0.095846395	
21.6	HB4	8	0.1807	0.077297328	
26.6	HB5	10	0.193	0.066628451	
3.7	HB6	10	0.215	0.084717453	
9.7	HB7	7	0.1708	0.068001776	
13.7	HB8	6.29568296		0.126	0.039303436
18.7	HB9	6.5	0.1346	0.04381533	
24.7	HB10	5.45884892		0.108	0.03707883
31.7	HB11	6.154829842		0.127266667	0.03553364
HB	average	7.380603795		0.161302424	0.061825061
	stdev(5)	4.208113693		0.097867937	0.042926272
	stdev(A)	3.535533906		0.074246212	0.032214991
	stdev(2)a		2.828427125	0.044264885	0.016088413
	stdev(2)b		0.707106781	0.015556349	0.005995424
	stdev(2)c		0.676567494	0.056423518	0.008707682
	stdevdouble		5.656854249	3.584578832	0.031935752
	avrstdev(2)		1.4040338	0.03874825	0.01026384
	season SD		1.57280368	0.036869596	0.021552318
	median	7	0.1708	0.066628451	
	average SD		2.105053773	0.053528172	0.018429448
	average SD(%)		28.52143038	33.18497673	29.8090251

Appendix 7. Ce-HB

sampling date	Ce	ash	Tw (ppm)	CR (ppm)	(ppm)
31.7	HB0	9	0.2079	0.059165974	
18.7	HB00	14	0.2932	0.089554719	
8.6	HB1	5.777280023		0.12936	0.050209275
12.6	HB2	8	0.1976	0.081643754	
16.6	HB3	8	0.192	0.095846395	
21.6	HB4	8	0.1807	0.077297328	
26.6	HB5	10	0.193	0.066628451	
3.7	HB6	10	0.215	0.084717453	
9.7	HB7	7	0.1708	0.068001776	
13.7	HB8	6.29568296		0.126	0.039303436
18.7	HB9	6.5	0.1346	0.04381533	
24.7	HB10	5.45884892		0.108	0.03707883
31.7	HB11	6.154829842		0.127266667	0.03553364
HB	average	7.380603795		0.161302424	0.061825061
	stdev(5)	4.208113693		0.097867937	0.042926272
	stdev(A)	3.535533906		0.074246212	0.032214991
	stdev(2)a		2.828427125	0.044264885	0.016088413
	stdev(2)b		0.707106781	0.015556349	0.005995424
	stdev(2)c		0.676567494	0.056423518	0.008707682
	stdevdouble		5.656854249	3.584578832	0.031935752
	avrstdev(2)		1.4040338	0.03874825	0.01026384
	season SD		1.57280368	0.036869596	0.021552318
	median 7		0.1708	0.066628451	
	average SD		2.105053773	0.053528172	0.018429448
	average SD(%)		28.52143038	33.18497673	29.8090251

Appendix 7. Ce-WS

sampling date	Ce	ash (ppm)	Tw (ppm)	CR (ppm)	
24.7	WS0	12	0.2544	0.104421355	
31.7	WS00	7	0.1281	0.044836755	
6.6	WS1	0	0	0	
12.6	WS2	9	0.2034	0.14154888	
16.6	WS3	8	0.1696	0.065911313	
21.6	WS4	6.5	0.1312	0.042277222	
26.6	WS5	6	0.1284	0.039470135	
3.7	WS6	5.5	0.124725	0.034424947	
9.7	WS7	6	0.1272	0.040037937	
13.7	WS8	9	0.1899	0.05929386	
18.7	WS9	4.48135463	0.103566667	0.029824505	
24.7	WS10	4.827071501	0.09575	0.034759617	
31.7	WS11	5.232947721	0.1531	0.042356583	
WS	average	5.867397623	0.129712879	0.048173182	
	st.dev(5)	4.679743583	0.088347928	0.028183132	
	st.dev.(A)	1.414213562	0.029839906	0.009317131	
	st.dev2a	0.680738246	0.020121216	0.001632357	
	st.dev.2b	0.244557828	0.002474874	0.002619429	
	st.dev.2c	0.521334703	0.081041533	0.003766595	
	st.dev.double	0.244557828	0.002474874	0.002619429	
	av.st.dev(2)	0.482210259	0.034545874	0.002672794	
	season SD	2.501539465	0.054669811	0.035205283	
	median	6	0.1284	0.040037937	
	average SD	1.53159359	0.047996388	0.009050378	
	average SD(%)	26.10345656	37.00202176	18.78717106	

Appendix 7. La-DB

sampling	La	ash	Tw (ppm)	CR (ppm)	(ppm)
13.7	DB0	3.1	0.062	0.023544507	
31.7	DB00	6.1	0.13137	0.042103366	
8.6	DB1	1.747355108		0.05255	0.01952581
12.6	DB2	2.567720509		0.06045	0.023330143
16.6	DB3	4.237604006		0.09956	0.035790674
21.6	DB4	3.9	0.09183	0.037625258	
26.6	DB5	3.4	0.0697	0.026978025	
3.7	DB6	2.942158243		0.066071	0.023771981
9.7	DB7	3.9	0.08151	0.035382254	
13.7	DB8	4.79482935		0.09296	0.036255218
18.7	DB9	2.420423652		0.042453333	0.016731002
24.7	DB10	2.149032247		0.0444	0.020139151
31.7	DB11	3.099717246		0.07913	0.02503503
DB	average	3.196258215		0.070964939	0.02732405
	st,dev(5)	0.45571158		0.014678744	0.002465539
	stdev(2)a		0.141421356	0.002955706	0.000822501
	stdev(2)b		0.11253795	0.012226599	0.000135811
	stdev(2)c		1.167026095	0.028864099	0.014699626
	stdev(A)	0.141421356		0.002955706	0.000822501
	stdevdouble(a)		0.07131049	0.000876812	0.000510642
	stdevdouble(b)		0.353553391	0.002008183	0.001259529
	stdevdouble(c)		1.060660172	0.024840661	0.006867857
	stdevdouble(d)		2.545584412	0.06112231	0.02230021
	avstdevdouble		1.007777116	0.022211992	0.00773456
	avstdev(2)		0.4736618	0.014682135	0.005219313
	season SD		0.945447765	0.019769951	0.007622826
	median	3.099717246		0.0697	0.02503503
	average SD		0.469174245	0.014681287	0.004530869
	average SD(%)		14.67885927	20.68808528	16.58198349

Appendix 7. La-DS ash

sampling date		La	Tw (ppm)	CR (ppm)	(ppm)
9.7	DS0	8.8	0.18058	0.088894005	
24.7	DS00	8.9	0.19402	0.071148034	
6.6	DS1	4.017844731		0.093107778	0.038052604
12.6	DS2	2.9	0.07047	0.024106155	
16.6	DS3	8.1	0.1701	0.06551766	
21.6	DS4	4.15	0.08844	0.033435839	
26.6	DS5	3.4	0.07684	0.029194498	
3.7	DS6	3.0309256		0.06732	0.022223204
9.7	DS7	2.6	0.05798	0.021906761	
13.7	DS8	6.2	0.124	0.055994381	
18.7	DS9	4.65	0.09678	0.035400904	
24.7	DS10	3.282864036		0.06068	0.026245294
31.7	DS11	5	0.1086	0.047458183	
DS	average	4.302875852		0.092210707	0.036321408
	st.dev(5)	1.171220947		0.026295925	0.010626725
	st.dev(2)a		1.060660172	0.013519882	0.008739391
	st.dev(2)b		2.899137803	0.065902352	0.022074085
	stdev(2)c		2.828427125	0.054305801	0.029606165
	stdev(A)	0.565685425		0.012727922	0.005203471
	av.st.dev(2)		2.2627417	0.044576011	0.020139881
	season SD		1.645285265	0.032979088	0.014435097
	median	4.017844731		0.08844	0.033435839
	average SD		1.989861512	0.04000599	0.017761592
	average SD(%)		46.24492038	43.38540636	48.90116561

Appendix 7. La-HB

sampling date	La	ash	Tw (ppm)	CR (ppm)	(ppm)
31.7	HB0	4.5	0.10395	0.029695537	
18.7	HB00	7.65	0.16038	0.049280199	
8.6	HB1	3.730224555		0.082526	0.032537358
12.6	HB2	4.4	0.10868	0.045041548	
16.6	HB3	4	0.096	0.048071203	
21.6	HB4	4.25	0.095465	0.040935291	
26.6	HB5	5	0.0965	0.033372855	
3.7	HB6	5.8	0.1247	0.049454293	
9.7	HB7	4.5	0.1098	0.043875799	
13.7	HB8	3.327718136		0.0666	0.020874023
18.7	HB9	4.9	0.10148	0.03316225	
24.7	HB10	2.456482014		0.0486	0.016735711
31.7	HB11	3.879184874		0.077666667	0.021809767
HB	average	4.203964507		0.09163797	0.0350791
	stdev(5)	1.803787352		0.04377117	0.020178243
	stdev(A)	0.070710678		0.001484924	0.000646957
	stdev(2)a		1.909188309	0.032887536	0.012672564
	stdev(2)b		0.707106781	0.015330075	0.005739028
	stdev(2)c		0.466921941	0.034747854	0.005755659
	stdevdouble		1.909188309	0.181831095	0.009885284
	avrstdev(2)		1.02773901	0.027655155	0.00805575
	season SD		0.893681657	0.021505716	0.011461909
	median	4.25	0.096	0.033372855	
	average SD		1.221751096	0.031684159	0.011086374
	average SD(%)		29.06187942	34.57536079	31.60392846

Appendix 7. La-WB

sampling date	La	ash	Tw (ppm)	CR (ppm)	(ppm)
24.7	WB0	1.2	0.03756	0.016258973	
31.7	WB00	4	0.0792	0.022932819	
6.6	WB1	3.499262408		0.082115	0.029828485
12.6	WB2	3.9	0.09282	0.031032564	
16.6	WB3	3.3	0.07656	0.020071448	
21.6	WB4	3.45	0.07705	0.029250721	
26.6	WB5	2.5	0.05625	0.01975223	
3.7	WB6	3.7	0.0851	0.040288197	
9.7	WB7	2.1	0.06384	0.033793971	
13.7	WB8	3.1	0.06758	0.020541967	
18.7	WB9	3.85	0.075625	0.026823975	
26.6	WB10	2.046255897		0.04416	0.017188905
31.7	WB11	2.736357014		0.07107	0.022725328
WB	average	3.107443211		0.072015455	0.026481617
	st.dev(5)	4.220406044		0.075953045	0.036630842
	st.dev.(A)		0.141421356	0.002800143	0.000325343
	st.dev(2)a		0.070710678	0.004030509	0.003263041
	st.dev(2)b		0.777817459	0.007544829	0.00620365
	st.dev(2)c		0.874925767	0.005854844	6.50051E-05
	st.dev(A)2		0	0	0
	avst.dev(2)		0.574484635	0.005810061	0.003177232
	season SD		0.66980698	0.013700163	0.007112725
	median 3.3		0.075625	0.026823975	
	average SD		1.485964987	0.023345807	0.011540635
	average SD(%)		47.819538	32.41777345	43.57979491

Appendix 7. La-WS

sampling date	La	ash (ppm)	Tw (ppm)	CR (ppm)	
24.7	WS0	5.6	0.11872	0.048945893	
31.7	WS00	4.8	0.08784	0.030859293	
6.6	WS1	2.674168432	0.04092	0.0188512	
12.6	WS2	4.5	0.1017	0.070791981	
16.6	WS3	3.4	0.07208	0.028117309	
21.6	WS4	4	0.080415	0.026057407	
26.6	WS5	4.3	0.09202	0.028374313	
3.7	WS6	3.989635962	0.0868975	0.026009967	
9.7	WS7	3.3	0.06996	0.022108853	
13.7	WS8	3.95	0.083345	0.026109206	
18.7	WS9	2.937694056	0.06283	0.019608042	
24.7	WS10	3.260077181	0.064415	0.023710377	
31.7	WS11	2.898651482	0.085613333	0.023612193	
WS	average	3.564566101	0.076381439	0.028486441	
	st.dev(5)	1.00506572	0.019533613	0.00513334	
	st.dev.(A)	0.070710678	0.001491995	0.000467392	
	st.dev2a	0.477571513	0.007162171	0.001307341	
	st.dev.2b	1.187830242	0.021969808	0.009183762	
	st.dev.2c	0.201115375	0.046182717	0.001377177	
	st.dev.double	1.187830242	0.021969808	0.009183762	
	av.st.dev(2)	0.622172377	0.025104899	0.003956093	
	season SD	0.612678997	0.016704067	0.014375321	
	median	3.4	0.080415	0.026009967	
	average SD	0.717895713	0.023712077	0.004250405	
	average SD(%)	20.13977837	31.04429209	14.92080106	

Appendix 7. Sm_DB

	Sm	ash	Tw	CR	
sampling date			(ppm)	(ppm)	(ppm)
13.7	DB0	0.3	0.006	0.002273136	
31.7	DB00	0.7	0.01507	0.004875309	
8.6	DB1	0.249622158	0.00709	0.002823541	
12.6	DB2	0.331318775	0.0078	0.003040733	
16.6	DB3	0.557579474	0.0131	0.004722239	
21.6	DB4	0.45	0.010605	0.004320468	
26.6	DB5	0.4	0.0082	0.003165866	
3.7	DB6	0.317346332	0.007152	0.002581984	
9.7	DB7	0.45	0.009405	0.004086236	
13.7	DB8	0.513731716	0.00996	0.003891135	
18.7	DB9	0.285048883	0.005243333	0.001986991	
24.7	DB10	0.268629031	0.00555	0.002499076	
31.7	DB11	0.352844313	0.00893	0.002860151	
DB	average	0.379647335	0.008457758	0.003270765	
	st,dev(5)	0.057018682	0.001849451	0.000358037	
	stdev(2)a	0.070710678	0.001477853	0.000694621	
	stdev(2)b	0.021144072	0.001091528	8.02427E-05	
	stdev(2)c	0.156082176	0.003790092	0.001858246	
	stdev(A)	0.070710678	0.001477853	0.000694621	
	stdevdouble(a)	0.02932164	0.000339411	9.98027E-05	
	stdevdouble(b)	0	0.00079196	0.000183132	
	stdevdouble(c)	0.070710678	0.001682914	0.000456808	
	stdevdouble(d)	0.282842712	0.006816509	0.002514804	
	avstdevdouble	0.095718758	0.002407699	0.000813637	
	avstdev(2)	0.082645642	0.002119825	0.000877703	
	season SD	0.102502506	0.002289116	0.000860758	
	median	0.352844313	0.0082	0.003040733	
	average SD	0.076238902	0.002052231	0.000747787	
	average SD(%)	20.08150596	24.26448351	22.86273754	

	Sm	ash	Tw	CR
		(ppm)	(ppm)	(ppm)
WS	average	0.428035535	0.009161212	0.003406943
	median	0.4	0.0096	0.00312194
	average SD	0.083767913	0.002874894	0.000519833
DS	average	0.504164673	0.010791061	0.004265982

	median	0.5	0.01064	0.004039184
	average SD	0.227935188	0.004569033	0.002024994
WB	average	0.379466304	0.008862727	0.003258349
	median	0.4	0.00912	0.003131478
	average SD	0.18044684	0.002674432	0.001261856
DB	average	0.379647335	0.008457758	0.003270765
	median	0.352844313	0.0082	0.003040733
	average SD	0.076238902	0.002052231	0.000747787
HB	average	0.505798744	0.010984879	0.004183685
	median	0.5	0.011155	0.004085821
	average SD	0.15194414	0.004159363	0.001386888

Appendix 7. Sm-DS

sampling date	Sm	ash	Tw (ppm)	CR (ppm)	(ppm)
9.7	DS0	0.95	0.019645		0.00967743
24.7	DS00	1.1	0.02398	0.008822509	
6.6	DS1	0.504137674		0.011466667	0.00477278
12.6	DS2	0.3	0.00729	0.002526931	
16.6	DS3	1	0.021	0.008108133	
21.6	DS4	0.5	0.01064	0.004039184	
26.6	DS5	0.4	0.00904	0.003439119	
3.7	DS6	0.336769511		0.00748	0.002479244
9.7	DS7	0.3	0.00669	0.002540605	
13.7	DS8	0.7	0.014	0.006316742	
18.7	DS9	0.55	0.011455		0.004202419
24.7	DS10	0.35490422		0.00656	0.002842638
31.7	DS11	0.6	0.01308	0.005658005	
DS	average	0.504164673		0.010791061	0.004265982
	st.dev(5)	0.133923295		0.003080406	0.001193163
	st.dev(2)a		0.141421356	0.00192333	0.001186329
	st.dev(2)b		0.353553391	0.00801152	0.002709614
	stdev(2)c		0.282842712	0.005260874	0.003010871
	stdev(A)	0.070710678		0.00159099	0.000653267
	av.st.dev(2)		0.259272486	0.005065242	0.002302271
	season SD		0.209767326	0.004262469	0.001819919
	median	0.5	0.01064	0.004039184	
	average SD		0.227935188	0.004569033	0.002024994
	average SD(%)		45.21046408	42.34090423	47.46842203

Appendix 7. Sm-HB

sampling date	Sm	ash	Tw (ppm)	CR (ppm)	(ppm)
31.7	HB0	0.5	0.01155	0.003325767	
18.7	HB00	0.9	0.01886	0.005859737	
8.6	HB1	0.429885894		0.009512	0.003746415
12.6	HB2	0.5	0.01235	0.005134909	
16.6	HB3	0.4	0.0096	0.004802396	
21.6	HB4	0.5	0.011155		0.004771877
26.6	HB5	0.6	0.01158	0.004085821	
3.7	HB6	0.8	0.0172	0.006793335	
9.7	HB7	0.6	0.01464	0.005880419	
13.7	HB8	0.44969164		0.009	0.002844907
18.7	HB9	0.55	0.01139	0.003768994	
24.7	HB10	0.272942446		0.0054	0.001898213
31.7	HB11	0.461266205		0.009006667	0.002293247
HB	average	0.505798744		0.010984879	0.004183685
	stdev(5)	0.189236541		0.004712257	0.002180503
	stdev(A)	0.070710678		0.001484924	0.000646863
	stdev(2)a		0.282842712	0.005211377	0.002060586
	stdev(2)b		0.070710678	0.001541493	0.000578373
	stdev(2)c		0.064986628	0.005172324	0.00072809
	stdevdouble		0.282842712	0.084074996	0.001553535
	avrstdev(2)		0.139513339	0.003975065	0.00112235
	season SD		0.135141585	0.003122973	0.001492816
	median	0.5	0.011155	0.004085821	
	average SD		0.15194414	0.004159363	0.001386888
	average SD(%)		30.04043439	37.86443912	33.1499231

Appendix 7. Sm-WB

sampling date	Sm	ash	Tw (ppm)	CR (ppm)	(ppm)
24.7	WB0	0.1	0.00313	0.00134889	
31.7	WB00	0.45	0.00891	0.002622026	
6.6	WB1	0.412996736		0.00998	0.003517198
12.6	WB2	0.5	0.0119	0.004016657	
16.6	WB3	0.4	0.00928	0.002461572	
21.6	WB4	0.45	0.01	0.00377486	
26.6	WB5	0.3	0.00675	0.002418575	
3.7	WB6	0.4	0.0092	0.00434059	
9.7	WB7	0.3	0.00912	0.004812679	
13.7	WB8	0.4	0.00872	0.002668706	
18.7	WB9	0.45	0.00886	0.003131478	
26.6	WB10	0.266902943		0.00576	0.002239528
31.7	WB11	0.29422966		0.00792	0.002459996
WB	average	0.379466304		0.008862727	0.003258349
	st.dev(5)	0.497025477		0.008986528	0.004271879
	st.dev.(A)		0.070710678	0.001400071	0.000468234
	st.dev(2)a		0.070710678	0.000848528	0.000125134
	st.dev(2)b		0.070710678	0.000480833	0.000569807
	st.dev(2)c		0.083340527	0.000381838	8.06026E-05
	st.dev(A)2		0	0	0
	avst.dev(2)		0.074920628	0.000570399	0.000258514
	season SD		0.077092897	0.001646828	0.000887424
	median	0.4	0.00912	0.003131478	
	average SD		0.18044684	0.002674432	0.001261856
	average SD(%)		47.55279675	30.17616952	38.72683853

Appendix 7. Sm-WS

sampling date	Sm	ash (ppm)	Tw (ppm)	CR (ppm)
24.7	WS0	0.7	0.01484	0.006153275
31.7	WS00	0.5	0.00915	0.003253638
6.6	WS1	0.324141628	0.00496	0.002314593
12.6	WS2	0.5	0.0113	0.007889298
16.6	WS3	0.4	0.00848	0.00333937
21.6	WS4	0.5	0.01007	0.003282316
26.6	WS5	0.5	0.0107	0.003330233
3.7	WS6	0.473927637	0.01029	0.00312194
9.7	WS7	0.4	0.00848	0.002703191
13.7	WS8	0.55	0.011605	0.003675373
18.7	WS9	0.34850837	0.007593333	0.002356486
24.7	WS10	0.38962429	0.007695	0.002835815
31.7	WS11	0.322188957	0.0096	0.002627751
WS	average	0.428035535	0.009161212	0.003406943
	st.dev(5)	0.107408228	0.002205791	0.000600183
	st.dev.(A)	0.070710678	0.001491995	0.000472524
	st.dev2a	0.068601195	0.001120774	0.000233529
	st.dev.2b	0.156094826	0.002906209	0.001197926
	st.dev.2c	0.002967402	0.005266802	4.76929E-05
	st.dev.double	0.156094826	0.002906209	0.001197926
	av.st.dev(2)	0.075887808	0.003097928	0.000493049
	season SD	0.079929648	0.00195942	0.001549066
	median	0.4	0.0096	0.00312194
	average SD	0.083767913	0.002874894	0.000519833
	average SD(%)	19.57031745	31.38115084	15.25804282

Appendix 7. Yb-DB

sampling date	Yb ash	Tw (ppm)	CR (ppm)	(ppm)
13.7	DB0	0	0	0
31.7	DB00	0.335	0.0071715	0.002414446
8.6	DB1	0.099848863	0.002909	0.001096951
12.6	DB2	0.14081048	0.003315	0.001375361
16.6	DB3	0.234183379	0.005502	0.00207234
21.6	DB4	0.25	0.005905	0.002565846
26.6	DB5	0	0	0
3.7	DB6	0.137746819	0.0030945	0.001170488
9.7	DB7	0.09	0.001881	0.000850228
13.7	DB8	0.248303663	0.004814	0.002018373
18.7	DB9	0.162026071	0.003165333	0.001203541
24.7	DB10	0.241766128	0.004995	0.002409942
31.7	DB11	0.181706588	0.004241	0.001520883
DB	average	0.162399272	0.003620167	0.001480359
	st,dev(5)	0.100250017	0.002182691	0.000830638
	stdev(2)a	0.127279221	0.002660136	0.001202403
	stdev(2)b	0.025418974	0.000532952	0.000128152
	stdev(2)c	0.019403094	0.000649124	0.000457324
	stdev(A)	0.127279221	0.002660136	0.001202403
	stdevdouble(a)	0.024664052	0.00034224	0.000105735
	stdevdouble(b)	0.098994949	0.002613467	0.000858772
	stdevdouble(c)	0.014142136	0.000372645	0.000102823
	stdevdouble(d)	0.06363961	0.001734533	0.00074691
	avstdevdouble	0.050360187	0.001265721	0.00045356
	avstdev(2)	0.057367096	0.001280737	0.00059596
	season SD	0.079674319	0.001722643	0.000748542
	median	0.162026071	0.003315	0.001375361
	average SD	0.068087827	0.001506226	0.000654629
	average SD(%)	41.92618956	41.60652706	44.22098413

Appendix 7,	Yb	Yb-DS ash	Tw	CR	
sampling date			(ppm)	(ppm)	(ppm)
9.7	DS0	0.355	0.0072805		0.003757119
24.7	DS00	0.5	0.0109	0.004225277	
6.6	DS1	0.219488678		0.005704444	0.002186469
12.6	DS2	0.17	0.004131		0.001486677
16.6	DS3	0.43	0.00903	0.003665731	
21.6	DS4	0.255	0.005564		0.002186296
26.6	DS5	0.39	0.008814		0.003562429
3.7	DS6	0.202061707		0.004488	0.001590709
9.7	DS7	0.27	0.006021		0.002412733
13.7	DS8	0.35	0.007	0.00334248	
18.7	DS9	0.35	0.0072905		0.00280942
24.7	DS10	0	0	0	
31.7	DS11	0.25	0.005406		0.002512859
DS	average	0.262413671		0.005768086	0.002341437
	st.dev(5)	0.062097269		0.002440166	0.000579306
	st.dev(2)a		0.049497475	0.001646145	0.000405183
	st.dev(2)b		0.22627417	0.005124403	0.001810548
	stdev(2)c		0.169705627	0.003343201	0.001833742
	stdev(A)	0.098994949		0.002227386	0.000945458
	av.st.dev(2)		0.148492424	0.003371249	0.001349824
	season SD		0.119523608	0.002481598	0.001064179
	median	0.255	0.005704444	0.002412733	
	average SD		0.126893635	0.003138479	0.001157195
	average SD(%)		48.35633553	54.41109491	49.4224243

Appendix 7, Yb-HB

sampling date	Yb	ash	Tw (ppm)	CR (ppm)	(ppm)
31.7	HB0	0.22	0.005082		0.001543078
18.7	HB00	0.395	0.008268		0.00269769
8.6	HB1	0.190544946		0.0042614	0.001864333
12.6	HB2	0.34	0.008398		0.003628792
16.6	HB3	0.14	0.00336	0.001736749	
21.6	HB4	0.29	0.0064625		0.002898753
26.6	HB5	0	0	0	
3.7	HB6	0.25	0.005375		0.002264274
9.7	HB7	0.27	0.006588		0.002775592
13.7	HB8	0	0	0	
18.7	HB9	0.14	0.002884		0.000992742
24.7	HB10	0	0	0	
31.7	HB11	0.140536446		0.004584	0.001288361
HB	average	0.160098308		0.003810264	0.001586327
	stdev(5)	0.156544305		0.003737376	0.001572817
	stdev(A)	0.22627417		0.004751758	0.002165436
	stdev(2)a		0.169705627	0.003152989	0.001328995
	stdev(2)b		0.197989899	0.004078592	0.00140395
	stdev(2)c		0.207336912	0.004041204	0.001822017
	stdevdouble		0.190918831	0.157851689	0.001199954
	avrstdev(2)		0.191677479	0.003757595	0.001518321
	season SD		0.121824348	0.002892458	0.001259303
	median	0.140536446		0.0042614	0.001736749
	average SD		0.182894186	0.00375254	0.001531945
	average SD(%)		114.2386748	98.4850546	96.57181089

Appendix 7. Yb-WB

sampling date	Yb	ash	Tw (ppm)	CR (ppm)	(ppm)
24.7	WB0	0	0	0	
31.7	WB00	0.155	0.003069		0.000963549
6.6	WB1	0.157249214		0.00341	0.001515176
12.6	WB2	0.24	0.005712		0.002012699
16.6	WB3	0	0	0	
21.6	WB4	0.105	0.002226		0.00085412
26.6	WB5	0.1	0.00225	0.000845066	
3.7	WB6	0.25	0.00575	0.002837497	
9.7	WB7	0.14	0.004256		0.002314324
13.7	WB8	0.22	0.004796		0.001550366
18.7	WB9	0.32	0.006265		0.002388697
26.6	WB10	0.275799708		0.005952	0.002481879
31.7	WB11	0.164279992		0.0041905	0.00145506
WB	average	0.179302628		0.004073409	0.001659535
	st.dev(5)	0.291022582		0.005336479	0.002680311
	st.dev.(A)		0.219203102	0.004340221	0.001362664
	st.dev(2)a		0.148492424	0.003148039	0.001207908
	st.dev(2)b		0.084852814	0.001028133	0.000709652
	st.dev(2)c		0.054853366	0.000405172	2.02935E-05
	st.dev(A)2		0	0	0
	avst.dev(2)		0.096066201	0.001527115	0.000645951
	season SD		0.092553742	0.001953658	0.000853796
	median	0.164279992		0.004256	0.001550366
	average SD		0.144805297	0.002479456	0.001154541
	average SD(%)		80.76027538	60.8693076	69.57015788

Appendix 7. Yb-WS

sampling date	Yb	ash (ppm)	Tw (ppm)	CR (ppm)	
24.7	WS0	0.21	0.004452	0.001953399	
31.7	WS00	0.2	0.00366	0.001379012	
6.6	WS1	0	0	0	
12.6	WS2	0.26	0.005876	0.00413257	
16.6	WS3	0.2	0.00424	0.001763406	
21.6	WS4	0.27	0.0053595	0.00186235	
26.6	WS5	0	0	0	
3.7	WS6	0.152722833	0.003403625	0.001032374	
9.7	WS7	0	0	0	
13.7	WS8	0.225	0.0047475	0.001583654	
18.7	WS9	0	0.001518	0	
24.7	WS10	0.11	0.002145	0.000865299	
31.7	WS11	0.229638317	0.004612333	0.002006777	
WS	average	0.131578286	0.002900178	0.001204221	
	st.dev(5)	0.134260474	0.003053817	0.000862834	
	st.dev.(A)	0.035355339	0.000745998	0.000248847	
	st.dev2a	0	0.002629253	0	
	st.dev.2b	0.155563492	0.003033488	0.001223717	
	st.dev.2c	0.019200924	0.000350751	0.000186801	
	st.dev.double	0.155563492	0.003033488	0.001223717	
	av.st.dev(2)	0.058254805	0.002004497	0.000470173	
	season SD	0.113508467	0.002258545	0.001267048	
	median	0.152722833	0.003403625	0.001032374	
	average SD	0.077256222	0.002266827	0.000568338	
	average SD(%)	58.71502403	78.16166371	47.19551397	

Appendix 9. Description of sampled trees.

	comment	circumference	crown	top	leader	date place	bark		
WS 0	13 m, no thick TW	36 cm	packed	7 branches+top		6 cm	semisunny	semicourse	24.7
WS00	11.5m, no thick TW	38 cm	packed	11 branches+top		6.5 cm	semisunny	semicourse	31.7
WS 1A		1/2 top of WB1							
WS 1B						6.6			
WS 2	no thick TW	packed			shade	course	12.6		
WS 3A									
WS 3B		1/2top of WB			sunny		16.6		
WS 4	no thick TW analyzed		packed			semisunny	fine	21.6	
WS 5		packed		semisunny		course	21.6		
WS 6		packed	1.4 cm	semisunny		semicourse	26.6		
WS 7		packed	1.8 cm		course	3.7			
WS 8A+B	Thick TW only		semipacked				course	3.7	
WS 9A		packed			course	3.7			
WS 9B									
WS 10-1	double CR, thick TW only		packed		3 cm		course		
WS 10-2	thick TW only	packed		0 cm			3.7		
WS 11A									
WS 11B		packed	2.5 cm		course	3.7			
WS 12	no thick TW	packed	top 3.5xsmaller than WB			8 cm	course	9.7	
WS 13	No thick TW	packed,wide				semisunny			
WS 13						13.7			
WS 14	no thick TW	packed	top1/2 of WB		6 cm	sunny	semicourse	18.7	
WS 15A									
WS 15B		packed	9 cm	semisunny		course	18.7		
WS 16-1A									
WS 16-1B		semipacked, narrow				6.5 cm			
WS 16A+B		semipacked		2.5 smaller WB16			5 cm		24.7
WS 17A									
WS 17B		semipacked, narrow		2.5xsmaller top than WB			7 cm	semisunny	course 31.7
WS 18A									
WS 18B		packed, narrow	1.5xsmaller than WB			7 cm	semisunny	course	31.7

	comment	circumference	crown	top	leader	date place	bark		
DS 0-1	12.5 m, double CR, used thick TW	35cm	loose	19 branches+top		7 cm	semisunny	course	9.7
DS 0-2	thick TW in sample, thick not used		loose			4 cm		9.7	
DS00	13 m, thick not used	36 cm	semipacked,narrow			10 branches+top,3x smaller top DB			4.5 cm
	sunny semicourse	24.7							
DS 1	tall 39 cm loose	small				6.6			
DS 1						6.6			
DS 2A									
DS 2B	tall 39 cm loose	small			fine	6.6			
DS 3	tall, used thin TW	38 cm	loose	small			fine	6.6	
DS 4A									

DS 4B	semitall	36.5 cm	loose	small			fine	6.6				
DS 5A	some pollen											
DS 5B	tall	32 cm		2x smaller than DB					fine	8.6		
DS 6		38 cm				sunny	course	12.6				
DS 7	tall, thin TW		35 cm	packed	very small				course	16.6		
DS 8	tall, thin TW		34 cm	packed		1 cm	semisunny		semicourse		21.6	
DS 9	thin TW	35 cm	packed			semisunny		course	21.6			
DS10	tall, thin TW		34 cm	semipacked		very small		1.2cm	semisunny		course	26.6
DS11A	moldy											
DS11B	moldy	34 cm	packed	2x smaller than WB			6 cm		semicourse		3.7	
DS12	thin TW used		36.5 cm	semipacked			11.5 cm	semisunny		semicourse		9.7
DS13	thin TW used		36.5 cm	packed, wide			4 cm	semisunny		semicourse		13.7
DS14	tall, rotten inside, thin TW used			38 cm	loose, narrow			1.3 less than DB14 and DS15				13 cm
	semisunny	course	18.7									
DS15	tall, thin TW		36 cm	packed, wide		3x less branches than DB15			10 cm	sunny	course	
	18.7											
DS16A												
DS16B	tall	34 cm	semipacked			16 cm	semisunny		semicourse		24.7	
DS17	tall, thin TW used			35.5 cm dried			9 cm	semisunny		semicourse		31.7
DS18A+B			34 cm	semipacked, narrow			2.5 smaler than DB18		8.5 cm	semisunny		
	semicourse	31.7										

	comment		circumference	crown	top	leader	place	bark	date		
WB 0	11.5 m	39 cm	loose	40 branches,3.5 bigger than WS			14 cm	semisunny		fine	24.7
WB00	11 m, 3/4 stem with branches			38.5 cm	packed, wide		more than 40 branches			12 cm	sunny
	course	31.7									
WB00											
WB 1A											
WB 1B	tall	38 cm	packed				6.6				
WB 2A											
WB 2B	tall	38 cm	packed				6.6				
WB 3A											
WB 3B		39 cm	top branches					6.6			
WB 4A											
WB 4B	very tall	39 cm					6.6				
WB 5A+B		very tall	35.5 cm		small top				6.6		
WB 6	thin TW used		36,5 cm	packed	branches to 1/3		sunny	course	12.6		
WB 7	thin TW used		35.5 cm	packed	2x bigger than WS3			sunny	course	16.6	
WB 8	thin TW used		34 cm	loose	twice as WS4,5	0.8 cm	semisunny		semicourse		21.6
WB 9	thin TW used		33.5 cm	packed	1.4 bigger than WS5,4		0.7 cm		semicourse		21.6
WB10	thin TW used		38 cm	packed	1.5x bigger than WS6		1.2 cm	semisunny		course	26.6
WB11		37 cm	top branches		2xbigger than WS				course	3.7	
WB12	used only thin TW			39 cm	top branches		12 cm		course	9.7	
WB13	thin TW used		36 cm	packed	1.5x bigger than WS		5 cm	sunny	course	13.7	
WB14	thin TW used		38.5 cm	packed, wide	similar to WB15		9 cm		course	18.7	
WB15	thin TW used, tall			38.5 cm	semipacked		2.5x bigger than WS15		4 cm	semisunny	
	semicourse	18.7									
WB16A											
WB16B	tall	34 cm	packed		7 cm	semisunny		semicourse		24.7	
WB17A											
WB17B		34 cm	semipacked, narrow		branches to 1/2 stem			8 cm	sunny	course	31.7

WB18A													
WB18b													
WB18A													
WB18B		35 cm	semipacked, narrow			branches almost to the bottom				6.5 cm	sunny	course	
	31.7												

	comment		circumference		crown	top	leader	place	bark	date		
HB 0	8 m	33 cm	packed, wide		40 branches to the bottom			13 cm	sunny	course	31.7	
HB00-1	11 m		packed, narrow		29 branches		7 cm	sunny	semicourse		18.7	
HB00-2			packed, narrow			7 cm						
HB 1		37 cm		rich			course	8.6				
HB 1								8.6				
HB 2		32.5 cm		medium			course	8.6				
HB 3		34 cm		rich			course	8.6				
HB 4A												
HB 4B				rich			course	8.6				
HB 5A												
HB 5B	small tree		30.5 cm		rich			course	8.6			
HB 6	thinTW used		37 cm	packed	branches down				course	12.6		
HB 7	semitall, thin TW used		32 cm	loose	2/3 of stem - branches					sunny	course	16.6
HB 8	semitall	32 cm	packed			semisunny		semicourse		21.6		
HB 9	semitall	35 cm	semipacked			0.9 cm		course	21.6			
HB 10		37 cm	very packed			0.8 cm	semisunny		course	26.6		
HB 11		35 cm	packed		5 cm		course	3.7				
HB 12		38 cm	semipacked			4.5 cm		course	9.7			
HB13A												
HB13B		36 cm	very packed, wide			1/3 trunk with branches			7 cm	semisunny		course
	13.7											
HB 14	some dust from road		37 cm		packed, wide			9 cm	semisunny		course	18.7
HB15	dust from road		37 cm		packed, wide		9 cm		semisunny	course	18.7	
HB16A												
HB16B		33 cm	packed, narrow			4 cm	semisunny		semicourse		24.7	
HB17A												
HB17B		34 cm	packed, wide			9 cm	semisunny		semicourse		31.7	
HB18A												
HB18B		35 cm	packed, narrow			8.5 cm	semisunny		course	31.7		
HB aver												

	comment		circumference	crown	top	leader	place	bark	date	
DB 0	11.8 m	37 cm	semipacked, narrow		40 branches+top		15 cm	semisunny		semicourse
	13.7									
DB00-1	11.5 m	38 cm	semipacked, narrow		35 branches+top to the half of trunk			8 cm		semisunny
	course	31.7								
DB00-2			semipacked, narrow			12 cm				
DB 1A	lots pollen									
DB1B	tall	32 cm				fine	8.6			
DB 1A										

DB 1B							8.6					
DB 2A												
DB 2B		36 cm		2.5 bigger than DS6			sunny	course	12.6			
DB 3A												
DB 3B		36 cm	packed	2.5 bigger than DS7			semisunny		course	16.6		
DB 4	rotten inside the trunk			32.5	loose	0.5 bigger than DS8,9			semisunny		course	21.6
DB 5		36 cm	loose	2x bigger than DS8,9			semisunny		course	21.6		
DB 6	moldy		semipacked	3.5 bigger than DS10			1.2 cm	semisunny		course	26.6	
DB 7-1	double crown		37 cm	packed		6 cm						
DB 7-2			packed		8cm	semisunny		semicourse		3.7		
DB 8-1	double crown		39 cm	packed		5 cm						
DB 8-2					6 cm	semisunny		semicourse		3.7		
DB 9A												
DB 9B		36 cm	packed		8 cm	semisunny		fine	3.7			
DB10A												
DB10B		39 cm	side branches			9 cm	semisunny		semicourse		3.7	
DB11		38 cm	loose		10 cm	semisunny		course	3.7			
DB12		36 cm	leading branches	2.5 times bigger than DS12				9 cm	sunny	course	9.7	
DB12							9.7					
DB13A												
DB13B		39 cm	packed, narrow	1.7 bigger than DS13			10 cm	semisunny		semicourse		
13.7												
DB14	tall	37.5 cm	packed	1.3 bigger than DS15			12 cm	semisunny		semicourse		18.7
DB15A												
DB15B		38 cm	packed, wide	branches almost down the trunk				11 cm	semisunny		course	
18.7												
DB16A												
DB16B	tall	34 cm	loose	1.5 bigger than DS16			10 cm	semisunny		semicourse		24.7
DB17		34 cm	loose, narrow	3.5 bigger than DS17			7.5 cm	semisunny		semicourse		
31.7												
DB18-1A												
DB18-1B				semipacked, narrow			6 cm					
DB18-2		34 cm	semipacked, narrow	branches to 1/2 of the trunk				12.5 cm	semisunny			
semicourse		31.7										

Appendix 10. ICP-AES analysis of outer bark

Site											
		Ag	Cd	Cu	Ni	Pb	Zn	Al	Ba	Co	Cr
Fe	K	Mg	Na	Sr	Ti	V	Y	Zr		Mn	Mo
As	Be	Bi	Ca	P	3b	Sc	Sn	W			
		ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm
%	%	%	%	ppm	%	ppm	ppm	ppm		ppm	ppm
ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm			
AL96/1106		db3	0.4	1.4	48	42	90	882	0.80	1590	8
16	1.24	1.08	0.78	0.06	510	0.06	18	4	10		2790
-4	-20	-2	-20	99999	2780	-10	-2	-20	20		
AL96/1107			db14	0.4	2.0	52	48	126	652	1.00	988
8	22	1.60	1.08	0.76	0.06	298	0.06	24	6	14	
1180	-4	-20	-2	-20	99999	2520	-10	-2	-20	-20	
AL96/1108			db15	0.4	2.0	40	42	100	604	0.94	870
8	22	1.46	1.12	0.80	0.06	424	0.06	22	4	12	
1640	-4	-20	-2	-20	99999	2720	-10	-2	-20	-20	
AL96/1109			db17-1	0.4	1.6	36	66	98	606	0.74	908
8	20	1.16	0.78	0.64	0.06	286	0.04	16	4	10	
1890	-4	-20	-2	-20	99999	1920	-10	-2	-20	-20	
AL96/1110			db17-2	0.4	2.2	38	44	102	586	0.78	840
8	18	1.22	0.80	0.64	0.06	278	0.06	18	4	10	
1810	-4	-20	-2	-20	99999	1970	-10	-2	-20	-20	
AL96/1112			db18	-0.4	1.4	40	46	104	642	1.00	984
8	22	1.54	0.94	0.70	0.06	294	0.06	22	4	12	
1370	-4	-20	-2	-20	99999	2340	-10	-2	-20	-20	
AL96/1113			wb7	0.4	2.4	40	34	88	800	0.64	424
6	14	0.98	1.10	0.78	0.06	946	0.04	16	4	8	
1930	-4	-20	-2	-20	99999	3120	-10	-2	-20	20	
AL96/1114			wb14	0.4	3.6	56	54	112	1280	0.94	292
8	20	1.40	1.48	1.10	0.08	524	0.06	22	6	8	
1910	-4	-20	-2	-20	99999	4210	-10	-2	-20	40	
AL96/1115			wb15	0.4	2.2	44	46	96	800	0.80	432
8	18	1.22	1.04	0.78	0.06	460	0.04	18	4	10	
1640	-4	-20	-2	-20	99999	3030	-10	-2	-20	20	
AL96/1116			wb17	0.4	1.4	42	36	104	678	0.94	908
8	22	1.50	1.02	0.78	0.06	382	0.06	22	4	12	
990	-4	-20	-2	-20	99999	2980	-10	-2	-20	20	
AL96/1117			wb18	0.4	2.4	50	50	106	874	0.84	392
8	18	1.26	1.40	0.74	0.06	542	0.04	20	4	6	
1220	-4	-20	-2	-20	99999	4230	-10	-2	-20	20	
AL96/1118			ds7	-0.4	2.2	48	48	142	564	0.98	748
10	24	1.62	0.96	0.68	0.06	308	0.06	24	6	12	
2390	-4	-20	-2	-20	99999	2630	-10	-2	-20	-20	
AL96/1119			ds14	-0.4	2.6	54	56	156	962	0.96	1010
10	20	1.56	1.04	0.80	0.06	310	0.06	22	6	12	
2390	-4	-20	-2	-20	99999	3130	-10	-2	-20	40	
AL96/1120			ds15	-0.4	3.8	38	44	96	698	0.80	1120
10	18	1.26	0.98	0.70	0.06	320	0.06	18	4	10	
3080	-4	-20	-2	-20	99999	2830	-10	-2	-20	20	

AL96/1121			ds17	-0.4	2.6	42	56	174	550	1.04	746
10	26	1.64	1.06	0.78	0.06	258	0.08	24	6	16	
2050	-4	-20	-2	-20	99999	2610	-10	-2	-20	-20	
AL96/1122			ds18	-0.4	2.4	44	58	160	450	1.06	662
8	24	1.76	1.04	0.60	0.04	286	0.08	26	6	12	
1300	-4	-20	-2	-20	99999	2920	-10	2	-20	-20	
AL96/1123			hb7	-0.4	-1.0	24	34	106	550	0.84	726
8	20	1.42	0.78	0.86	0.04	592	0.08	18	4	14	
1240	-4	-20	-2	-20	99999	1260	-10	-2	-20	-20	
AL96/1124			hb14	-0.4	1.4	34	42	134	596	1.28	790
10	30	2.14	1.12	0.94	0.06	340	0.12	28	4	18	
1110	-4	-20	-2	-20	99999	1970	-10	2	-20	-20	
AL96/1125			hb15	0.4	1.8	42	50	172	622	1.16	254
10	28	1.92	1.16	1.10	0.08	310	0.10	26	6	18	
1310	-4	-20	-2	-20	99999	2060	-10	2	-20	-20	
AL96/1126			hb17	-0.4	1.6	30	38	108	652	0.92	338
8	20	1.54	1.06	0.90	0.06	358	0.08	20	4	14	
1250	-4	-20	-2	-20	99999	1990	-10	-2	-20	-20	
AL96/1127			hb18	0.4	2.2	42	50	158	1170	1.12	218
10	28	1.90	1.60	1.48	0.10	356	0.10	26	4	18	
1840	-4	-20	-2	-20	99999	2670	-10	-2	-20	40	
AL96/1128			ws3	0.4	3.6	60	40	120	800	0.82	656
8	18	1.38	1.22	0.70	0.06	688	0.04	20	6	10	
1670	-4	-20	-2	-20	99999	3850	-10	-2	-20	-20	
AL96/1129			ws14	0.4	5.0	66	54	100	2100	0.68	510
6	14	1.20	1.66	0.78	0.04	1010	0.04	18	4	8	
2130	-4	-20	-2	-20	99999	5600	-10	-2	-20	60	
AL96/1130			ws15	0.4	3.2	52	52	108	1090	0.90	368
8	20	1.52	1.48	0.86	0.06	730	0.06	22	4	10	
1390	-4	-20	-2	-20	99999	4560	-10	-2	-20	40	
AL96/1131			ws17-1	0.4	3.0	56	52	120	1330	0.80	222
8	18	1.28	1.42	0.94	0.06	560	0.04	20	6	10	
1730	-4	-20	-2	-20	99999	4190	-10	-2	-20	40	
AL96/1132			ws17-2	0.4	3.2	58	54	124	1310	0.90	288
8	20	1.42	1.52	0.96	0.06	570	0.06	22	6	12	
1690	-4	-20	-2	-20	99999	4450	-10	-2	-20	60	
AL96/1134			ws18	0.4	2.4	48	52	102	816	0.80	190
8	18	1.26	1.46	0.90	0.06	394	0.06	20	4	12	
1110	-4	-20	-2	-20	99999	3890	-10	-2	-20	40	
AL96/1133			V6c	0.4	3.6	126	58	248	624	1.10	266
8	44	1.52	2.12	2.30	0.24	600	0.04	30	8	4	
716	4	-20	-2	-20	99999	7630	-10	-2	-20	-20	
AL96/1111			V6c	0.4	3.8	128	58	250	622	1.14	274
8	44	1.50	2.14	2.28	0.24	608	0.04	32	8	6	
720	4	-20	-2	-20	99999	7580	-10	-2	-20	-20	

Appendix 10 - ICP-AES analysis of twig ashes

SAMPLE	Ag	Cd	Cu	Mn	Mo	Ni	Pb	Zn	Al	As	Ba
Be	Bi	Ca	Co	Cr	Fe	K	Mg	Na	P	Sb	Sc
Sn	Sr	Ti	V	W	Y	Zr					
	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm
	ppm	%	ppm	ppm	%	%	%	%	ppm	ppm	ppm
	ppm	%	ppm	ppm	ppm	ppm					
ICP96-1243	0.6	1.6	200	3790	4	54	20	1500	0.36	-20	480
-2	-20	99999	4	10	0.46	99999	6.18	0.06	46500	-10	-2
-20	780	-0.02	8	20	-2	-2					
ICP96-1244	0.8	1.4	196	4760	4	60	16	2420	0.26	-20	860
-2	-20	99999	4	8	0.36	99999	5.92	0.06	48500	-10	-2
-20	680	-0.02	6	40	-2	-2					
ICP96-1245	0.8	1.2	136	4160	4	36	8	2110	0.20	-20	348
-2	-20	99999	2	8	0.30	99999	7.18	0.06	59400	-10	-2
-20	558	-0.02	4	40	-2	-2					
ICP96-1246	1.3	1.7	166	5460	-4	32	6	1820	0.17	-20	764
-2	-20	99999	4	6	0.25	99999	9.43	0.04	44300	-10	-2
-20	630	-0.02	4	42	-2	-2					
ICP96-1247	0.6	1.4	138	5190	6	48	8	2240	0.26	-20	246
-2	-20	99999	4	8	0.36	99999	6.50	0.04	53200	-10	-2
-20	650	-0.02	6	40	-2	-2					
ICP96-1248	0.8	2.2	186	4400	6	36	20	1630	0.50	-20	454
-2	-20	99999	4	12	0.62	99999	3.82	0.08	42300	-10	-2
-20	630	-0.02	12	40	-2	-2					
ICP96-1249	0.8	1.0	144	4900	-4	14	6	1290	0.24	-20	982
-2	-20	99999	4	6	0.30	99999	2.98	0.04	26900	-10	-2
-20	692	-0.02	6	-20	-2	-2					
ICP96-1250	0.8	1.2	132	4640	-4	28	8	1730	0.26	-20	496
-2	-20	99999	4	8	0.32	99999	4.12	0.04	35900	-10	-2
-20	628	-0.02	6	40	-2	-2					
ICP96-1251	0.8	-1.0	146	6050	-4	32	6	1790	0.18	-20	412
-2	-20	99999	4	4	0.26	99999	5.84	0.04	32600	-10	-2
-20	826	-0.02	4	40	-2	-2					
ICP96-1252	0.8	1.2	166	5770	4	30	12	2100	0.26	-20	484
-2	-20	99999	4	8	0.36	99999	4.96	0.06	42800	-10	-2
-20	790	-0.02	6	40	-2	-2					
ICP96-1253	0.6	1.4	146	6110	-4	34	10	1610	0.26	-20	492
-2	-20	99999	4	6	0.32	99999	5.22	0.06	40500	-10	-2
-20	664	-0.02	6	20	-2	-2					
ICP96-1254	0.8	2.2	138	5430	-4	32	12	2260	0.28	-20	548
-2	-20	99999	4	8	0.34	99999	9.10	0.06	48500	-10	-2
-20	554	-0.02	6	40	-2	-2					
ICP96-1255	0.9	2.6	166	8060	-4	34	9	2400	0.24	-20	381
-2	-20	99999	4	6	0.30	99999	6.90	0.06	51400	-10	-2
-20	630	-0.02	4	43	-2	-2					
ICP96-1257	0.8	1.4	128	7380	-4	42	12	1880	0.24	-20	410
-2	-20	99999	4	6	0.30	99999	6.30	0.08	39600	-10	-2
-20	760	-0.02	6	40	-2	-2					
ICP96-1258	0.6	1.4	144	5760	-4	62	12	2060	0.34	-20	510
-2	-20	99999	4	8	0.42	99999	5.58	0.10	45300	-10	-2
-20	694	-0.02	8	40	-2	-2					

ICP96-1259	0.8	-1.0	172	5300	4	36	6	1950	0.20	-20	494
-2	-20	99999	4	8	0.26	99999	6.70	0.06	45800	-10	-2
-20	700	-0.02	4	40	-2	-2					
ICP96-1260	0.9	1.5	194	4310	-4	26	-4	1550	0.13	-20	713
-2	-20	99999	2	4	0.18	99999	8.49	0.04	35200	-10	-2
-20	719	-0.02	2	22	-2	-2					
ICP96-1261	1.0	2.4	136	3410	6	22	6	1440	0.18	-20	674
-2	-20	99999	2	6	0.24	99999	4.56	0.04	53500	-10	-2
-20	450	-0.02	4	20	-2	-2					
ICP96-1262	0.6	1.4	144	5290	-4	24	8	2370	0.24	-20	628
-2	-20	99999	4	6	0.30	99999	3.92	0.04	36800	-10	-2
-20	706	-0.02	6	40	-2	-2					
ICP96-1263	0.6	1.2	146	5410	-4	24	10	2460	0.24	-20	572
-2	-20	99999	2	6	0.30	99999	3.98	0.04	37300	-10	-2
-20	724	-0.02	6	40	-2	-2					
ICP96-1264	-0.4	3.4	122	694	4	54	214	586	1.00	-20	256
-2	-20	99999	8	40	1.36	1.94	2.18	0.22	7400	-10	-2
-20	574	0.04	28	-20	8	4					
ICP96-1265	0.6	-1.0	194	5250	-4	42	4	1770	0.14	-20	456
-2	-20	99999	4	6	0.22	99999	7.02	0.04	50500	-10	-2
-20	566	-0.02	4	40	-2	-2					
ICP96-1266	0.6	1.4	142	4300	-4	32	8	2320	0.16	-20	472
-2	-20	99999	2	6	0.24	99999	4.32	0.06	41800	-10	-2
-20	1040	-0.02	4	40	-2	-2					
ICP96-1267	0.8	1.6	106	3870	-4	30	10	1870	0.16	-20	322
-2	-20	99999	2	6	0.22	99999	5.10	0.08	30600	-10	-2
-20	888	-0.02	4	40	-2	-2					
ICP96-1268	0.6	2.6	122	4930	6	34	12	1890	0.24	-20	352
-2	-20	99999	4	6	0.32	99999	5.74	0.08	38100	-10	-2
-20	724	-0.02	6	40	-2	-2					
ICP96-1269	0.6	1.0	113	4230	-4	20	6	1400	0.12	-20	636
-2	-20	99999	2	4	0.19	99999	6.56	0.04	30800	-10	-2
-20	675	-0.02	4	20	-2	-2					
ICP96-1270	0.6	1.2	122	4740	4	34	12	1810	0.20	-20	428
-2	-20	99999	2	6	0.26	99999	6.14	0.04	35800	-10	-2
-20	722	-0.02	4	40	-2	-2					
ICP96-1271	0.6	1.2	144	3610	4	54	14	1810	0.26	-20	354
-2	-20	99999	4	8	0.34	99999	5.84	0.06	37500	-10	-2
-20	708	-0.02	6	20	-2	-2					
ICP96-1272	0.6	2.2	130	4250	-4	36	12	1650	0.24	-20	662
-2	-20	99999	4	6	0.30	99999	5.32	0.04	27700	-10	-2
-20	772	-0.02	6	40	-2	-2					
ICP96-1273	0.8	2.2	144	3230	-4	66	18	1740	0.40	-20	626
-2	-20	99999	4	10	0.50	99999	5.18	0.08	37900	-10	-2
-20	658	-0.02	10	40	-2	-2					
ICP96-1274	1.2	2.0	118	4800	-4	44	12	1300	0.28	-20	438
-2	-20	99999	4	8	0.38	99999	4.98	0.04	25700	-10	-2
-20	662	-0.02	6	20	-2	-2					
ICP96-1275	1.0	2.7	162	10200	-4	101	16	1770	0.41	-20	398
-2	-20	99999	12	10	0.47	99999	2.89	0.06	47200	-10	-2
-20	361	-0.02	8	41	-2	-2					
ICP96-1276	1.0	3.0	180	10600	-4	114	36	1850	0.66	-20	302
-2	-20	99999	12	18	0.78	99999	2.84	0.10	43000	-10	-2
-20	386	0.02	14	20	2	-2					

ICP96-1277	0.8	1.8	236	7860	-4	122	22	2110	0.62	-20	590
-2	-20	99999	8	18	0.74	99999	4.56	0.10	41400	-10	-2
-20	388	0.02	12	40	2	-2					
ICP96-1278	1.2	1.6	224	11200	-4	106	8	1780	0.34	-20	276
-2	-20	99999	12	8	0.38	99999	4.04	0.06	48500	-10	-2
-20	354	-0.02	6	20	-2	-2					
ICP96-1279	1.0	1.8	210	10600	-4	100	6	1680	0.32	-20	288
-2	-20	99999	12	8	0.36	99999	3.80	0.06	46400	-10	-2
-20	334	-0.02	6	40	-2	-2					
ICP96-1280	-0.4	3.0	136	740	4	60	240	618	1.14	-20	276
-2	-20	99999	8	44	1.48	2.08	2.28	0.22	7640	-10	-2
-20	606	0.04	32	-20	8	6					
ICP96-1281	1.8	2.4	264	12400	-4	94	10	1770	0.34	-20	238
-2	-20	99999	24	8	0.40	99999	3.46	0.06	53700	-10	-2
-20	420	-0.02	6	40	-2	-2					
ICP96-1282	2.4	2.6	240	11700	-4	84	10	1610	0.34	-20	540
-2	-20	99999	22	8	0.42	99999	2.72	0.04	28700	-10	-2
-20	472	-0.02	6	20	-2	-2					
ICP96-1283	1.2	2.6	296	12100	-4	104	16	1790	0.30	-20	320
-2	-20	99999	18	8	0.44	99999	4.54	0.04	49300	-10	-2
-20	416	-0.02	8	40	-2	2					
ICP96-1284	1.0	3.0	240	11600	-4	142	34	1800	0.40	-20	288
-2	-20	99999	8	8	0.38	99999	3.94	0.04	40700	-10	-2
-20	574	-0.02	6	40	-2	4					
ICP96-1285	1.6	1.0	178	12200	-4	86	16	1560	0.34	-20	740
-2	-20	99999	8	6	0.34	99999	3.74	0.04	26100	-10	-2
-20	580	-0.02	6	20	-2	2					
ICP96-1286	1.0	1.0	182	9220	-4	120	16	1810	0.24	-20	506
-2	-20	99999	8	8	0.32	99999	3.92	0.04	59500	-10	-2
-20	370	-0.02	6	40	-2	2					
ICP96-1287	1.2	1.2	170	11600	-4	94	12	1830	0.24	-20	1120
-2	-20	99999	8	6	0.32	99999	4.24	0.04	42400	-10	-2
-20	468	-0.02	6	40	-2	-2					
ICP96-1288	1.4	2.2	228	17100	-4	102	8	1660	0.16	-20	342
-2	-20	99999	16	6	0.24	99999	3.08	0.04	41700	-10	-2
-20	334	-0.02	4	40	-2	2					
ICP96-1289	1.0	1.8	182	8560	-4	112	22	1440	0.52	-20	388
-2	-20	99999	12	14	0.66	99999	3.52	0.06	37700	-10	-2
-20	494	0.02	12	20	2	4					
ICP96-1290	1.0	1.2	260	11400	-4	112	12	1430	0.30	-20	304
-2	-20	99999	8	8	0.28	99999	4.30	0.04	38000	-10	-2
-20	854	-0.02	4	20	-2	-2					
ICP96-1291	1.0	1.4	168	8590	-4	112	12	1400	0.30	-20	608
-2	-20	99999	6	8	0.36	99999	7.26	0.04	31900	-10	-2
-20	612	-0.02	6	-20	-2	-2					
ICP96-1292	1.4	1.6	172	10200	-4	110	14	1670	0.28	-20	338
-2	-20	99999	10	8	0.30	99999	4.92	0.04	40100	-10	-2
-20	588	-0.02	4	20	-2	-2					
ICP96-1293	0.8	1.6	200	16500	-4	112	16	2070	0.40	-20	616
-2	-20	99999	12	8	0.44	99999	4.90	0.06	29900	-10	-2
-20	446	-0.02	8	40	-2	-2					
ICP96-1294	1.1	1.3	204	11300	-4	94	6	1610	0.27	-20	1100
-2	-20	99999	13	6	0.29	99999	5.48	0.04	26100	-10	-2
-20	403	-0.02	4	21	-2	-2					

ICP96-1295	1.2	1.2	156	11100	-4	90	4	1630	0.20	-20	434
-2	-20	99999	12	6	0.20	99999	5.68	0.02	50100	-10	-2
-20	326	-0.02	2	40	-2	-2					
ICP96-1296	2.2	1.2	366	12500	-4	176	22	1890	0.38	-20	454
-2	-20	99999	14	10	0.50	99999	3.54	0.04	41500	-10	-2
-20	516	-0.02	8	40	-2	-2					
ICP96-1297	1.0	-1.0	248	12500	-4	78	4	1780	0.16	-20	1220
-2	-20	99999	10	6	0.20	99999	5.06	0.04	47800	-10	-2
-20	378	-0.02	2	40	-2	-2					
ICP96-1298	1.0	2.2	234	9110	-4	164	16	1210	0.46	-20	582
-2	-20	99999	14	12	0.56	99999	4.56	0.06	37600	-10	-2
-20	386	-0.02	10	20	-2	-2					
ICP96-1299	1.4	1.4	240	8560	-4	106	12	1620	0.38	-20	460
-2	-20	99999	16	8	0.34	99999	4.20	0.04	47800	-10	-2
-20	498	-0.02	6	20	-2	-2					
ICP96-1300	1.5	2.1	231	9440	-4	132	15	1340	0.40	-20	630
-2	-20	99999	19	8	0.34	99999	4.22	0.04	37100	-10	-2
-20	559	-0.02	4	21	-2	-2					
ICP96-1301	1.6	2.6	184	7820	-4	112	26	1520	0.48	-20	536
-2	-20	99999	14	10	0.52	99999	3.20	0.06	28000	-10	-2
-20	470	-0.02	10	20	-2	-2					
ICP96-1302	1.2	1.2	188	10600	-4	80	8	1320	0.30	-20	550
-2	-20	99999	10	8	0.26	99999	4.44	0.04	33600	-10	-2
-20	570	-0.02	4	20	-2	-2					
ICP96-1303	0.4	-1.0	124	1140	4	20	-4	1710	0.04	-20	550
-2	-20	99999	-2	4	0.10	99999	4.24	0.02	32500	-10	-2
-20	772	-0.02	-2	20	-2	-2					
ICP96-1304	1.0	-1.0	178	5410	-4	36	4	1830	0.18	-20	766
-2	-20	99999	6	6	0.28	99999	5.48	0.04	43200	-10	-2
-20	608	-0.02	4	40	-2	2					
ICP96-1305	1.0	-1.0	178	5390	4	36	8	1810	0.18	-20	798
-2	-20	99999	6	6	0.28	99999	5.54	0.04	44100	-10	-2
-20	602	-0.02	4	40	-2	2					
ICP96-1306	0.4	3.8	120	708	4	68	232	592	1.08	-20	266
-2	-20	99999	8	42	1.44	2.02	2.22	0.22	7440	-10	-2
-20	588	0.04	30	20	8	6					
ICP96-1307	0.6	2.2	196	5760	-4	72	12	2250	0.26	-20	338
-2	-20	99999	4	8	0.38	99999	6.88	0.04	53800	-10	-2
-20	626	-0.02	6	40	-2	2					
ICP96-1308	1.0	1.8	272	6650	-4	48	4	1870	0.16	-20	640
-2	-20	99999	4	6	0.26	99999	8.30	0.04	41400	-10	-2
-20	710	-0.02	4	20	-2	-2					
ICP96-1309	0.8	2.4	194	5280	-4	46	18	2100	0.28	-20	334
-2	-20	99999	2	8	0.38	99999	7.56	0.04	41500	-10	-2
-20	948	-0.02	6	40	-2	2					
ICP96-1310	1.0	-1.0	184	5950	-4	30	8	1760	0.16	-20	1150
-2	-20	99999	4	4	0.22	99999	8.64	0.04	30400	-10	-2
-20	928	-0.02	4	20	-2	-2					
ICP96-1311	1.0	1.0	176	5200	8	20	8	2270	0.24	-20	754
-2	-20	99999	4	8	0.36	99999	5.10	0.04	56600	-10	-2
-20	620	-0.02	6	40	-2	2					
ICP96-1312	1.2	-1.0	186	6870	4	10	-4	1800	0.10	-20	1120
-2	-20	99999	2	4	0.14	99999	5.36	0.02	42500	-10	-2
-20	730	-0.02	2	40	-2	-2					

ICP96-1313	0.6	-1.0	142	4240	6	24	8	1980	0.18	-20	300
-2	-20	99999	2	6	0.24	99999	4.92	0.04	54500	-10	-2
-20	786	-0.02	4	40	-2	-2					
ICP96-1314	1.0	-1.0	144	5200	-4	14	6	1830	0.08	-20	990
-2	-20	99999	2	4	0.14	99999	5.00	0.02	37800	-10	-2
-20	882	-0.02	-2	40	-2	-2					
ICP96-1315	1.2	3.6	234	4540	-4	44	56	2060	0.66	-20	702
-2	-20	99999	6	14	0.84	99999	3.28	0.08	34000	-10	-2
-20	820	0.02	14	40	4	-2					
ICP96-1316	1.2	1.6	160	4680	4	30	14	1620	0.24	-20	386
-2	-20	99999	4	6	0.34	99999	4.78	0.04	43100	-10	-2
-20	604	-0.02	6	20	-2	-2					
ICP96-1317	1.0	-1.0	174	7310	6	22	8	1360	0.20	-20	712
-2	-20	99999	4	6	0.26	99999	4.50	0.04	42600	-10	-2
-20	738	-0.02	4	-20	-2	-2					
ICP96-1318	0.6	1.4	182	4900	-4	36	12	1920	0.20	-20	422
-2	-20	99999	4	6	0.26	99999	4.74	0.04	26800	-10	-2
-20	746	-0.02	4	40	-2	-2					
ICP96-1319	1.0	1.2	258	5530	6	44	10	2150	0.26	-20	352
-2	-20	99999	4	6	0.32	99999	7.62	0.06	41100	-10	-2
-20	758	-0.02	6	40	-2	-2					
ICP96-1320	0.6	1.0	132	5450	4	26	6	1780	0.16	-20	914
-2	-20	99999	2	6	0.24	99999	6.06	0.04	44000	-10	-2
-20	590	-0.02	4	40	-2	-2					
ICP96-1321	1.0	1.4	174	8690	-4	78	10	1770	0.24	-20	1380
-2	-20	99999	8	6	0.30	99999	5.82	0.08	37300	-10	-2
-20	488	-0.02	6	40	-2	-2					
ICP96-1322	0.6	1.4	160	1470	-4	14	12	1540	0.12	-20	1090
-2	-20	99999	4	6	0.18	99999	2.86	0.04	27500	-10	-2
-20	1040	-0.02	2	20	-2	-2					
ICP96-1323	0.4	2.6	116	4830	-4	22	10	1960	0.20	-20	814
-2	-20	99999	2	6	0.26	99999	5.42	0.06	41300	-10	-2
-20	492	-0.02	4	40	-2	-2					
ICP96-1324	0.6	1.8	158	6290	-4	40	16	1930	0.24	-20	734
-2	-20	99999	4	8	0.32	99999	6.48	0.06	50000	-10	-2
-20	682	-0.02	6	40	-2	-2					
ICP96-1325	1.4	2.2	212	10900	-4	62	12	1960	0.20	-20	286
-2	-20	99999	6	6	0.28	99999	8.12	0.06	42200	-10	-2
-20	614	-0.02	4	40	-2	-2					
ICP96-1326	0.8	1.4	148	5350	-4	22	14	1970	0.18	-20	724
-2	-20	99999	4	6	0.26	99999	5.84	0.04	34900	-10	-2
-20	754	-0.02	4	40	-2	-2					
ICP96-1327	1.0	-1.0	124	6650	-4	14	10	1540	0.12	-20	1120
-2	-20	99999	2	4	0.20	99999	6.30	0.02	25600	-10	-2
-20	792	-0.02	2	40	-2	-2					
ICP96-1328	0.8	1.6	136	3640	-4	34	16	1930	0.36	-20	886
-2	-20	99999	4	10	0.48	99999	4.46	0.06	37500	-10	-2
-20	622	-0.02	8	40	-2	-2					
ICP96-1329	0.8	1.6	114	4350	-4	22	10	1640	0.28	-20	852
-2	-20	99999	4	8	0.36	99999	4.84	0.04	26600	-10	-2
-20	680	-0.02	6	20	-2	-2					
ICP96-1330	0.8	-1.0	120	4590	-4	28	12	1650	0.26	-20	1390
-2	-20	99999	4	6	0.32	99999	5.28	0.06	34100	-10	-2
-20	844	-0.02	6	40	-2	-2					

ICP96-1331	0.8	1.0	124	4750	-4	30	12	1690	0.26	-20	1420
-2	-20	99999	4	8	0.34	99999	5.40	0.06	35100	-10	-2
-20	870	-0.02	6	40	-2	-2					
ICP96-1332	-0.4	3.2	210	738	4	56	242	630	1.12	-20	278
-2	-20	99999	8	42	1.46	2.14	2.32	0.22	7770	-10	-2
-20	618	0.04	30	-20	8	6					
ICP96-1333	1.2	1.4	92	5490	-4	20	6	1640	0.18	-20	1480
-2	-20	99999	4	6	0.22	99999	7.04	0.04	29400	-10	-2
-20	904	-0.02	4	40	-2	-2					
ICP96-1334	1.2	1.0	244	2870	4	48	6	1880	0.24	-20	536
-2	-20	99999	4	8	0.34	99999	3.88	0.06	46200	-10	-2
-20	528	-0.02	6	40	-2	-2					
ICP96-1335	0.4	-1.0	122	3240	-4	58	16	2150	0.38	-20	460
-2	-20	99999	4	10	0.48	99999	5.74	0.08	39600	-10	-2
-20	476	-0.02	8	40	-2	-2					
ICP96-1336	0.8	4.2	154	3940	-4	76	36	2590	0.58	-20	620
-2	-20	99999	6	14	0.74	99999	5.22	0.12	35600	-10	-2
-20	598	0.02	14	40	2	-2					
ICP96-1337	0.6	1.0	136	7200	-4	46	6	2110	0.22	-20	300
-2	-20	99999	4	8	0.30	99999	6.70	0.06	53700	-10	-2
-20	862	-0.02	6	40	-2	-2					
ICP96-1338	0.8	-1.0	140	7560	-4	50	12	2180	0.24	-20	300
-2	-20	99999	4	8	0.32	99999	6.96	0.06	53100	-10	-2
-20	908	-0.02	6	40	-2	-2					
ICP96-1339	0.4	3.6	132	732	4	60	246	620	1.12	-20	274
-2	-20	99999	8	46	1.48	2.14	2.26	0.22	7730	-10	-2
-20	596	0.04	32	20	8	6					
ICP96-1340	0.6	-1.0	124	6920	-4	50	12	2040	0.26	-20	338
-2	-20	99999	4	8	0.34	99999	6.06	0.04	46800	-10	-2
-20	952	-0.02	6	40	-2	-2					
ICP96-1341	0.8	1.6	138	6720	-4	42	14	2060	0.34	-20	434
-2	-20	99999	4	10	0.42	99999	5.66	0.06	46800	-10	-2
-20	904	-0.02	8	40	-2	-2					
ICP96-1342	0.8	1.4	154	6560	-4	56	8	2390	0.28	-20	280
-2	-20	99999	4	8	0.38	99999	6.78	0.06	43900	-10	-2
-20	990	-0.02	6	40	-2	2					
ICP96-1343	1.0	1.0	158	6680	-4	34	8	1920	0.14	-20	564
-2	-20	99999	2	4	0.20	99999	8.28	0.04	33000	-10	-2
-20	926	-0.02	4	40	-2	-2					
ICP96-1344	0.8	-1.0	212	5140	4	60	8	2010	0.20	-20	312
-2	-20	99999	4	8	0.30	99999	4.28	0.06	53100	-10	-2
-20	580	-0.02	4	40	-2	-2					
ICP96-1345	1.6	-1.0	222	6270	-4	46	4	1760	0.12	-20	454
-2	-20	99999	2	6	0.18	99999	5.06	0.04	38100	-10	-2
-20	716	-0.02	2	40	-2	-2					
ICP96-1346	0.6	2.2	140	5120	-4	56	10	2220	0.30	-20	858
-2	-20	99999	4	10	0.40	99999	4.46	0.06	44000	-10	-2
-20	576	-0.02	8	60	-2	-2					
ICP96-1347	0.8	2.2	158	5560	-4	56	12	1320	0.22	-20	496
-2	-20	99999	4	8	0.30	99999	3.52	0.06	28800	-10	-2
-20	910	-0.02	6	20	-2	-2					
ICP96-1348	0.8	2.8	140	6090	-4	58	14	1720	0.38	-20	558
-2	-20	99999	4	10	0.46	99999	4.82	0.06	33500	-10	-2
-20	884	-0.02	8	40	-2	-2					

ICP96-1349	0.8	-1.0	152	8440	-4	36	4	1700	0.16	-20	354
-2	-20	99999	4	6	0.22	99999	6.60	0.04	33500	-10	-2
-20	1050	-0.02	4	40	-2	-2					
ICP96-1350	0.8	1.2	126	3740	-4	48	10	1720	0.28	-20	366
-2	-20	99999	4	10	0.38	99999	4.54	0.08	43300	-10	-2
-20	1090	-0.02	6	40	-2	-2					
ICP96-1351	1.0	1.0	136	8400	-4	52	20	1830	0.36	-20	768
-2	-20	99999	4	10	0.44	99999	7.60	0.08	37000	-10	-2
-20	734	-0.02	8	40	-2	-2					
ICP96-1352	0.4	2.2	126	3780	4	48	8	2190	0.28	-20	872
-2	-20	99999	4	8	0.36	99999	4.70	0.06	43300	-10	-2
-20	810	-0.02	6	40	-2	-2					
ICP96-1353	0.6	1.8	122	4910	-4	50	18	1790	0.34	-20	384
-2	-20	99999	4	10	0.44	99999	6.50	0.06	37500	-10	-2
-20	1050	-0.02	8	40	-2	-2					
ICP96-1354	0.8	-1.0	90	3740	-4	26	6	1250	0.22	-20	546
-2	-20	99999	2	6	0.28	99999	7.32	0.04	24100	-10	-2
-20	1080	-0.02	6	20	-2	-2					
ICP96-1355	0.6	1.8	128	4430	-4	48	10	2070	0.28	-20	702
-2	-20	99999	4	8	0.36	99999	5.20	0.06	37500	-10	-2
-20	1010	-0.02	6	40	-2	-2					
ICP96-1356	0.6	1.4	128	4610	-4	42	14	2010	0.26	-20	748
-2	-20	99999	2	8	0.34	99999	4.82	0.06	31900	-10	-2
-20	750	-0.02	6	40	-2	-2					
ICP96-1357	0.6	2.0	106	4100	-4	52	16	1340	0.34	-20	912
-2	-20	99999	4	10	0.44	99999	5.48	0.08	31400	-10	-2
-20	882	-0.02	8	20	-2	-2					
ICP96-1358	0.6	-1.0	82	3280	-4	24	8	854	0.20	-20	1050
-2	-20	99999	4	6	0.26	99999	5.28	0.04	23200	-10	-2
-20	854	-0.02	4	20	-2	-2					
ICP96-1359	0.8	1.6	136	7920	-4	50	14	1790	0.34	-20	756
-2	-20	99999	4	10	0.40	99999	5.32	0.06	29800	-10	-2
-20	846	-0.02	8	40	-2	-2					
ICP96-1360	1.2	1.0	98	7140	-4	33	8	1480	0.23	-20	1600
-2	-20	99999	4	6	0.31	99999	4.98	0.02	22000	-10	-2
-20	822	-0.02	6	41	-2	-2					
ICP96-1361	0.8	1.2	138	4920	-4	48	14	2630	0.32	-20	786
-2	-20	99999	4	8	0.44	99999	5.44	0.04	41600	-10	-2
-20	674	-0.02	8	60	-2	-2					
ICP96-1362	1.4	-1.0	130	7100	-4	28	6	2440	0.20	-20	1470
-2	-20	99999	4	6	0.28	99999	6.68	0.02	34900	-10	-2
-20	828	-0.02	4	40	-2	-2					
ICP96-1363	1.4	1.0	244	12500	-4	132	4	1660	0.24	-20	494
-2	-20	99999	12	8	0.24	99999	3.96	0.04	61600	-10	-2
-20	386	-0.02	4	40	-2	2					
ICP96-1364	1.2	1.2	184	8250	-4	74	18	1600	0.60	-20	1180
-2	-20	99999	8	16	0.70	99999	5.10	0.06	34000	-10	-2
-20	576	0.02	12	20	2	-2					
ICP96-1365	1.2	-1.0	222	10200	-4	80	8	1760	0.42	-20	1130
-2	-20	99999	8	12	0.46	99999	7.36	0.06	48400	-10	-2
-20	606	-0.02	8	40	-2	-2					
ICP96-1366	2.4	1.8	274	9730	-4	190	12	1580	0.30	-20	272
-2	-20	99999	12	8	0.38	99999	4.62	0.04	61900	-10	-2
-20	486	-0.02	6	40	-2	-2					

ICP96-1367	2.2	2.0	264	9320	-4	182	10	1530	0.30	-20	266
-2	-20	99999	12	10	0.36	99999	4.46	0.04	60400	-10	-2
-20	462	-0.02	6	20	-2	-2					
ICP96-1368	0.4	3.6	170	826	4	76	266	678	1.26	-20	314
-2	-20	99999	8	52	1.68	2.44	2.60	0.26	8940	-10	2
-20	698	0.04	36	-20	10	6					
ICP96-1369	2.8	1.4	250	10700	-4	188	8	1360	0.20	-20	394
-2	-20	99999	14	6	0.24	99999	5.74	0.02	42500	-10	-2
-20	520	-0.02	4	20	-2	2					
ICP96-1370	1.2	1.0	176	11700	-4	108	12	1610	0.24	-20	294
-2	-20	99999	8	8	0.28	99999	3.90	0.02	50500	-10	-2
-20	466	-0.02	4	40	-2	2					
ICP96-1371	2.0	2.0	182	14200	-4	104	14	1420	0.26	-20	830
-2	-20	99999	10	8	0.26	99999	4.66	0.02	33000	-10	-2
-20	556	-0.02	4	20	-2	-2					
ICP96-1372	1.0	1.8	148	11300	-4	126	14	1760	0.32	-20	388
-2	-20	99999	8	10	0.38	99999	3.94	0.06	36600	-10	-2
-20	622	-0.02	6	40	-2	-2					
ICP96-1373	1.4	2.4	160	11300	-4	116	12	1580	0.30	-20	848
-2	-20	99999	10	8	0.34	99999	4.96	0.04	34900	-10	-2
-20	612	-0.02	6	40	-2	-2					
ICP96-1374	1.0	2.0	234	11900	-4	156	12	1210	0.30	-20	912
-2	-20	99999	10	8	0.34	99999	3.78	0.06	32500	-10	-2
-20	510	-0.02	6	20	-2	-2					
ICP96-1375	1.6	-1.0	204	14500	-4	102	8	1560	0.24	-20	360
-2	-20	99999	8	6	0.18	99999	5.20	0.04	34700	-10	-2
-20	542	-0.02	2	20	-2	-2					
ICP96-1376	1.2	2.4	236	16700	-4	86	12	1570	0.26	-20	918
-2	-20	99999	8	6	0.32	99999	5.40	0.06	44000	-10	-2
-20	514	-0.02	4	40	-2	-2					
ICP96-1377	1.2	1.2	142	12500	-4	106	14	1710	0.28	-20	1070
-2	-20	99999	8	6	0.32	99999	4.38	0.08	32400	-10	-2
-20	398	-0.02	6	40	-2	-2					
ICP96-1378	1.2	-1.0	144	11100	-4	108	6	1710	0.22	-20	924
-2	-20	99999	8	6	0.24	99999	5.32	0.08	39400	-10	-2
-20	358	-0.02	4	20	-2	-2					
ICP96-1379	1.0	-1.0	160	11200	-4	86	10	1410	0.24	-20	1060
-2	-20	99999	10	6	0.26	99999	3.94	0.08	25600	-10	-2
-20	492	-0.02	4	20	-2	-2					
ICP96-1380	1.0	1.4	174	12600	-4	86	8	1470	0.26	-20	644
-2	-20	99999	10	6	0.26	99999	3.94	0.06	26700	-10	-2
-20	512	-0.02	4	20	-2	-2					
ICP96-1381	1.4	-1.0	198	22500	-4	108	6	2180	0.22	-20	452
-2	-20	99999	10	6	0.24	99999	5.62	0.06	48300	-10	-2
-20	344	-0.02	4	40	-2	2					
ICP96-1383	1.2	1.2	182	17100	-4	132	10	1490	0.30	-20	526
-2	-20	99999	22	8	0.28	99999	5.88	0.06	42400	-10	-2
-20	496	-0.02	4	40	-2	-2					
ICP96-1384	1.6	-1.0	252	11000	-4	128	4	1120	0.24	-20	1560
-2	-20	99999	20	6	0.18	99999	5.22	0.04	33700	-10	-2
-20	512	-0.02	2	20	-2	-2					
ICP96-1385	1.2	1.4	198	13500	-4	88	8	1240	0.20	-20	408
-2	-20	99999	10	6	0.20	99999	6.14	0.06	49100	-10	-2
-20	398	-0.02	4	40	-2	-2					

ICP96-1386	1.8	3.8	284	15600	-4	126	10	1760	0.22	-20	534
-2	-20	99999	18	6	0.26	99999	4.76	0.06	45100	-10	-2
-20	474	-0.02	4	40	-2	-2					
ICP96-1387	1.6	4.8	286	15600	-4	130	10	1770	0.22	-20	496
-2	-20	99999	16	6	0.26	99999	4.84	0.06	45800	-10	-2
-20	472	-0.02	4	40	-2	-2					
ICP96-1368	0.4	3.6	170	826	4	76	266	678	1.26	-20	314
-2	-20	99999	8	52	1.68	2.44	2.60	0.26	8940	-10	2
-20	698	0.04	36	-20	10	6					
ICP96-1389	1.4	-1.0	196	12300	-4	110	10	1670	0.24	-20	282
-2	-20	99999	10	8	0.24	99999	5.16	0.04	48900	-10	-2
-20	630	-0.02	4	40	-2	-2					
ICP96-1391	0.8	1.6	154	8310	-4	80	16	1410	0.28	-20	388
-2	-20	99999	4	8	0.36	99999	5.76	0.06	39600	-10	-2
-20	540	-0.02	6	40	-2	-2					
ICP96-1392	1.2	-1.0	174	13300	-4	72	8	1580	0.22	-20	310
-2	-20	99999	10	8	0.24	99999	4.80	0.04	44800	-10	-2
-20	622	-0.02	4	40	-2	-2					
ICP96-1393	1.0	-1.0	158	10700	-4	66	4	1200	0.18	-20	382
-2	-20	99999	8	6	0.18	99999	4.40	0.04	31500	-10	-2
-20	614	-0.02	4	20	-2	-2					
ICP96-1394	1.2	2.0	224	11900	-4	98	10	1630	0.20	-20	292
-2	-20	99999	10	6	0.24	99999	3.46	0.06	37300	-10	-2
-20	474	-0.02	4	40	-2	-2					
ICP96-1395	1.2	1.0	170	11400	-4	74	4	1180	0.16	-20	424
-2	-20	99999	10	4	0.20	99999	3.10	0.04	28000	-10	-2
-20	466	-0.02	4	20	-2	-2					
ICP96-1396	1.2	1.4	164	8780	-4	84	12	1650	0.24	-20	280
-2	-20	99999	6	6	0.24	99999	3.14	0.04	31500	-10	-2
-20	390	-0.02	4	40	-2	-2					
ICP96-1397	1.0	1.0	194	6930	-4	74	16	1370	0.32	-20	724
-2	-20	99999	6	8	0.36	99999	3.54	0.06	26300	-10	-2
-20	388	-0.02	6	40	-2	-2					
ICP96-1399	1.0	-1.0	200	6810	-4	66	6	1470	0.22	-20	688
-2	-20	99999	4	6	0.22	99999	4.96	0.04	37000	-10	-2
-20	360	-0.02	4	40	-2	-2					

Appendix 10. INAA analysis of the outer bark.

Element		Site	ASH	AU	AG	AS	BA	BR	CA	CO	CR	CS
FE	HF	HG	IR	K	MO	NA	NI	RB	SB	SC	SE	SN
SR	TA	TH	U	W	ZN	LA	CE	ND	SM	EU	TB	YB
LU	Mass											
Units			%	PPB	PPM	PPM	PPM	PPM	%	PPM	PPM	PPM
%	PPM	PPM	PPB	%	PPM	PPM	PPM	PPM	PPM	PPM	PPM	%
PPM	PPM	PPM	PPM	PPM	PPM	PPM	PPM	PPM	PPM	PPM	PPM	PPM
PPM	g											
Detection Limit					5	2	0.5	10	1	0.2	1	1
	0.5	0.05	0.5	1	2	0.05	2	10	50	5	0.1	0.1
	2	0	300	0.5	0.1	0.1	1	20	0.1	3	5	0.1
	0.01	0.5	0.05	0.05	0							
AL96/1106			db3	4.6	16	-2	2.2	1800	20	18.2	9	40
	1	1.45	3.7	-1	-2	2.46	-2	10700	-50	60	0.7	3.9
	-2	-0.006	590	-0.5	6.2	1.1	-1	970	22	40	17	2.1
	0.54	-0.5	0.67	0.11	0.51							
AL96/1107				db14	5.57	-5	-2	3.1	990	45	16.7	10
	46	1.8	1.52	3.9	-1	-2	2.84	-2	11500	-50	63	0.7
	4.1	-2	-0.006	-300	-0.5	7.3	1.4	-1	720	25	48	17
	2.4	0.62	-0.5	0.85	0.17	0.56						
AL96/1108				db15	5.81	12	-2	2.9	1500	31	17.5	9
	41	1.4	1.52	3.6	-1	-2	3.01	-2	10900	-50	54	0.7
	3.9	-2	-0.007	1100	-0.5	7.1	1.3	-1	700	23	41	19
	2.2	0.63	-0.5	0.85	0.14	0.54						
AL96/1109				db17-1	6.96	6	-2	2.1	1200	36	23	9
	34	1.2	1.13	2.9	-1	-2	2.06	-2	8720	-50	43	0.5
	2.9	-2	-0.006	410	-0.5	5.5	1	2	750	18	29	15
	1.7	0.54	-0.5	0.73	0.1	0.61						
AL96/1110				db17-2		6	-2	2.3	1200	36	21.5	9
	38	1.5	1.2	3.2	-1	-2	1.71	-2	8980	-50	52	0.6
	3	-2	-0.007	-300	0.5	5.4	0.9	-1	660	19	33	14
	1.7	0.46	-0.5	0.61	0.09	0.52						
AL96/1111					v6c	16	-2	6.5	380	10	14.7	9
	61	0.8	1.61	4.5	-1	-2	3.02	4	11200	-50	40	1
	4.2	-2	-0.006	850	-0.5	2.6	1	-1	750	18	38	20
	2.6	0.77	-0.5	1.63	0.26	0.52						
AL96/1112				db18	7.02	10	-2	3	850	34	17.3	10
	45	0.9	1.48	3.7	-1	-2	2.62	3	12100	-50	73	0.8
	4.1	-2	-0.007	420	1	7.6	1.1	-1	670	24	40	20
	2.3	0.56	-0.5	0.84	0.14	0.61						
AL96/1113				wb7	4.87	13	-2	2.8	2400	44	22.5	8
	34	0.8	1.07	3.5	-1	-2	1.96	-2	7530	-50	38	0.5
	2.9	-2	-0.007	1500	-0.5	4.4	0.9	-1	960	17	30	15
	1.7	0.53	-0.5	0.66	0.12	0.55						
AL96/1114				wb14	4.05	24	-2	4.7	1500	36	18.9	9
	36	1.7	1.43	3.5	-1	-2	2.42	2	9870	-50	68	1
	3.8	-2	-0.007	880	-0.5	5.4	1.2	-1	1500	21	38	15
	2.1	0.55	-0.5	0.76	0.14	0.55						
AL96/1115				wb15	6.1	-5	-2	3.4	2200	24	18.9	8
	36	1.2	1.28	4	-1	-2	2.6	-2	9970	-50	44	0.7
	3.7	-2	-0.007	860	-0.5	5.5	1.2	2	850	21	37	17
	2	0.52	-0.5	0.76	0.13	0.62						

AL96/1116			wb17	5.82	15	-2	3.3	1200	37	15.9	9
44	1.6	1.58	4.1	-1	-2	2.56	-2	13000	110	55	0.7
4.5	-2	-0.007	800	-0.5	7.7	1.4	-1	880	26	46	20
2.5	0.67	-0.5	0.83	0.17	0.63						
AL96/1117			wb18	5.11	11	-2	3.7	1900	37	17.8	8
34	1.4	1.27	3.3	-1	-2	2.41	-2	9760	-50	48	0.9
3.7	-2	-0.007	990	-0.5	6	1.4	-1	1000	20	36	19
2.1	0.59	-0.5	0.87	0.15	0.61						
AL96/1118			ds7	7.72	-5	-2	2.8	2100	60	19.2	12
43	1.4	1.61	4.2	-1	-2	2.28	2	10400	-50	66	0.8
4.2	-2	-0.008	-300	-0.5	7.5	1.5	-1	750	28	47	23
2.7	0.7	-0.5	0.92	0.17	0.59						
AL96/1119			ds14	5.78	-5	-2	2.7	1500	32	17.8	10
42	1.5	1.62	4	-1	-2	2.62	-2	11500	-50	69	0.9
4.2	-2	-0.007	920	0.6	7.7	1.4	-1	1100	29	48	23
2.6	0.63	-0.5	0.96	0.17	0.59						
AL96/1120			ds15	6.27	8	-2	1.8	1700	32	23	10
32	1.1	1.19	3	-1	-2	2.1	-2	7930	130	37	0.6
3.1	-2	-0.006	660	-0.5	5.7	0.7	-1	890	19	33	14
1.9	0.43	-0.5	0.73	0.12	0.61						
AL96/1121			ds17	7.73	-5	-2	3.1	1500	33	13.5	11
49	2.1	1.76	4.5	-1	-2	2.6	-2	14000	120	69	0.9
4.6	-2	-0.007	-300	-0.5	9.9	1.4	2	530	32	54	24
2.9	0.72	-0.5	0.93	0.19	0.67						
AL96/1122			ds18	8.31	-5	-2	3.8	1600	44	14.4	10
46	1.6	1.82	4.2	-1	-2	2.73	-2	12800	-50	72	1.2
4.8	-2	-0.007	-300	-0.5	8.2	1.6	-1	540	30	52	23
2.9	0.73	-0.5	1.11	0.19	0.61						
AL96/1123			hb7	9.1	15	-2	2.6	930	13	16.3	8
44	-0.5	1.42	3.8	-1	-2	2.11	-2	13500	-50	55	0.4
3.6	-2	-0.006	1100	-0.5	9.1	1.8	-1	630	27	45	20
2.3	0.57	-0.5	0.61	0.11	0.73						
AL96/1124			hb14	8.89	16	-2	1.7	950	16	12.7	10
50	2.1	1.93	4.8	-1	-3	3.23	-2	17200	-50	75	0.5
4.9	-2	-0.008	760	-0.5	11	1.9	-1	820	33	56	20
2.8	0.75	-0.5	0.97	0.11	0.52						
AL96/1125			hb15	6.87	-5	-2	2.6	820	13	12.1	10
48	1.8	1.91	4.6	-1	-2	3.05	3	16500	-50	68	0.7
4.6	-2	-0.007	540	0.7	11	1.6	-1	660	33	57	22
2.8	0.75	-0.5	0.74	0.17	0.65						
AL96/1126			hb17	8	15	-2	2.9	880	19	14.5	8
38	1.5	1.5	3.9	-1	-2	2.57	2	14000	-50	60	0.5
3.7	-2	-0.006	660	-0.5	8.3	1.3	-1	730	25	43	17
2.2	0.58	-0.5	0.7	0.14	0.69						
AL96/1127			hb18	8.11	10	-2	4.7	1000	27	11.4	10
46	1.6	1.77	5	-1	-2	3.64	-2	16700	-50	83	0.7
4.6	-2	-0.007	-300	-0.5	10	1.9	-1	1200	31	53	20
2.7	0.75	-0.5	0.84	0.15	0.66						
AL96/1128			ws3	4.87	32	-2	3.3	2400	43	19.9	8
36	1.2	1.34	3.6	-1	-2	2.16	2	8720	-50	29	0.9
3.7	-2	-0.006	820	-0.5	5.1	1.1	-1	880	22	37	18
2.2	0.63	-0.5	0.91	0.17	0.64						
AL96/1129			ws14	2.95	15	-2	3.5	3900	37	22	7
29	1.6	1.16	3.5	-1	-2	2.51	-2	7850	-50	45	0.8
3.2	-2	-0.007	1500	0.9	4.1	0.9	-1	2100	17	31	11
1.8	0.38	-0.5	0.69	0.11	0.54						

AL96/1130			ws15	4.25	15	-2	3.4	2300	17	15	7
37	1.4	1.49	4.4	-1	-2	2.92	3	12000	-50	48	0.8
4.2	-2	-0.006	1000	-0.5	6	1.1	2	1100	23	40	20
2.3	0.71	-0.5	0.87	0.19	0.69						
AL96/1131			ws17-1	4.44	31	-2	5.8	1800	23	15.6	8
41	1.5	1.47	4.2	-1	-2	2.6	2	11500	-50	69	1
4.1	-2	-0.007	1000	-0.5	6.3	1	-1	1300	24	43	21
2.4	0.64	-0.5	0.91	0.17	0.58						
AL96/1132			ws17-2		22	-2	5.8	1600	22	15.3	8
40	1.6	1.48	4	-1	-2	2.9	-2	11300	-50	58	0.9
4.2	-2	-0.006	790	-0.5	6	1.6	3	1200	23	40	20
2.3	0.62	-0.5	0.96	0.15	0.78						
AL96/1133				v6c	16	-2	6.4	390	9	14.4	9
63	0.9	1.65	4.6	-1	-2	3.27	3	11300	-50	42	0.9
4.1	-2	-0.006	980	-0.5	3	0.9	-1	760	21	40	20
2.7	0.78	-0.5	1.67	0.26	0.57						
AL96/1134			ws18	4.43	15	-2	5.2	1100	23	16.1	8
35	1.2	1.35	3.2	-1	-2	2.48	-2	9790	-50	59	1.1
3.6	-2	-0.007	750	-0.5	6.7	1.1	-1	980	21	37	18
2.2	0.58	-0.5	0.83	0.14	0.53						

Appendix 10 - INAA analusis of twig ashes

Element		AU	AG	AS	BA	BR	CA	CO	CR	CS	FE	HF
HG	IR	K	MO	NA	NI	RB	SB	SC	SE	SN	SR	TA
TH	U	W	ZN	LA	CE	ND	SM	EU	TB	YB	LU	Mass
Units		PPB	PPM	PPM	PPM	PPM	%	PPM	PPM	PPM	%	PPM
PPM	PPB	%	PPM	PPM	PPM	PPM	PPM	PPM	PPM	%	PPM	PPM
PPM	PPM	PPM	PPM	PPM	PPM	PPM	PPM	PPM	PPM	PPM	PPM	g
Detection Limit			5	2	0.5	10	1	0.2	1	1	0.5	0.05
	0.5	1	2	0.05	2	10	50	5	0.1	0.1	2	0
	300	0.5	0.1	0.1	1	20	0.1	3	5	0.1	0.01	0.5
	0.05	0.05	0									
AL96/1243			WS 0	45	-2	2.6	1200	26	13.2	4	15	0.9
	0.51	0.8	-1	-2	17.8	5	3050	-50	52	0.3	1.4	-2
	-0.005	1400	-0.5	1.6	0.8	-1	1700	5.6	12	-5	0.7	0.12
	-0.5	0.21	0.07	0.53								
AL96/1244			WS00	53	-2	2.2	680	21	15.1	4	13	0.6
	0.47	0.9	-1	-2	23.5	-2	2930	-50	100	0.2	1.3	-2
	-0.007	1100	-0.5	1	0.8	-1	2700	4.8	7	7	0.5	0.22
	-0.5	0.2	0.05	0.48								
AL96/1245			WS 1A	23	-2	1.6	790	33	14.2	4	10	-0.5
	0.39	-0.5	-1	-3	17	8	1820	-50	72	0.2	1.1	-2
	-0.009	720	1	0.9	-0.1	-1	2300	3.7	6	-5	0.5	-0.04
	-0.5	-0.05	-0.05	0.31								
AL96/1246			WS 1B	26	-2	2.3	1100	34	17.1	6	10	0.8
	0.33	0.9	-1	-4	21.5	-2	1710	-50	70	0.3	1.2	-2
	-0.012	-300	-0.5	0.5	-0.2	-1	2400	3.3	-3	-5	0.4	-0.05
	-0.5	-0.05	-0.05	0.15								
AL96/1247			WS 2	42	-2	2.5	1100	30	16.2	4	14	-0.5
	0.43	0.7	-1	-2	15.6	6	2090	-50	47	0.2	1.2	-2
	-0.006	850	-0.5	1.1	-0.1	-1	2400	4.5	9	-5	0.5	-0.03
	-0.5	0.26	0.07	0.55								
AL96/1248			WS 3A	35	-2	2.6	830	46	16.1	6	18	0.9
	0.65	1.4	-1	-2	16.5	6	3170	-50	48	0.3	1.9	-2
	-0.007	840	-0.5	1.8	0.7	-1	1700	7.4	15	10	0.9	0.24
	-0.5	0.54	0.08	0.55								
AL96/1249			WS 3B	10	-2	1.2	780	24	24.3	4	13	0.8
	0.4	0.7	-1	-2	15.2	-2	1680	-50	33	0.2	1.1	-2
	-0.007	1100	-0.5	0.9	-0.1	-1	1500	3.4	8	-5	0.4	-0.03
	-0.5	0.2	0.07	0.34								
AL96/1250			WS 4	43	-2	2.3	980	30	22.8	4	15	1.6
	0.45	0.8	-1	-3	14.7	-2	2130	81	46	0.1	1.3	-2
	-0.009	730	-0.5	1.1	-0.1	-1	2000	4.7	8	-5	0.6	-0.03
	-0.5	0.27	-0.05	0.29								
AL96/1251			WS 5	29	-2	2.9	1400	34	21.4	4	11	1.7
	0.35	0.5	-1	-2	19	4	1530	-50	58	0.2	1	-2
	-0.008	1200	-0.5	0.9	-0.1	-1	2000	3.3	5	-5	0.4	-0.03
	-0.5	0.27	-0.05	0.31								
AL96/1252			WS 6	11	-2	2.9	810	29	18.4	4	11	0.8
	0.41	0.6	-1	-2	17.1	6	2000	-50	42	0.2	1.2	-2
	-0.008	720	0.6	0.9	-0.1	-1	2300	4.3	6	-5	0.5	0.38
	-0.5	-0.05	-0.05	0.36								
AL96/1253			WS 7	30	-2	1.6	950	42	18.3	4	12	0.9
	0.41	0.5	-1	-2	19.8	-2	1890	-50	54	0.2	1.2	-2

-0.008	800	-0.5	0.9	-0.1	-1	1900	4.2	8	7	0.5	-0.03
-0.5	0.17	-0.05	0.34								
AL96/1254		WS 8A+B		24	-2	3.1	960	59	11.8	5	14
1.1	0.45	-0.5	-1	-3	22.5	-2	2110	-50	92	0.2	1.3
-2	-0.009	-300	-0.5	0.9	-0.1	-1	2400	4.1	5	-5	0.5
-0.03	-0.5	-0.05	-0.05	0.32							
AL96/1255		WS 9A	57	-2	3.1	950	40	14.3	5	14	1.1
0.44	-0.5	-1	-3	17.2	-2	2160	-50	70	0.2	1.3	-2
-0.01	910	-0.5	1.1	0.7	-1	2800	4.2	7	-5	0.5	-0.04
-0.5	-0.05	-0.05	0.24								
AL96/1256		WS 9B	14	-2	2.4	1100	43	18.3	5	16	-0.5
0.4	-0.5	-1	-3	17.7	-2	2250	-50	60	0.3	1.2	-2
-0.009	1100	-0.5	1	-0.1	-1	2400	3.9	-3	-5	0.5	-0.03
-0.5	0.22	-0.05	0.25								
AL96/1257		WS 10-159		-2	3	1000	36	17.5	5	16	0.9
0.38	0.7	-1	-2	18	-2	2330	-50	51	0.2	1.2	-2
-0.008	1300	-0.5	0.9	-0.1	-1	2100	4.1	9	-5	0.5	-0.03
-0.5	0.19	-0.05	0.34								
AL96/1258		WS 10-248		-2	2.6	900	33	16.2	5	19	0.7
0.5	0.7	-1	-2	20.5	-2	3000	150	65	0.4	1.5	-2
-0.008	730	-0.5	1.3	-0.1	-1	2300	5.5	11	-5	0.6	-0.03
-0.5	0.35	0.06	0.34								
AL96/1259		WS 11A	47	-2	2.5	650	33	17.3	5	9	-0.5
0.35	-0.5	-1	-2	17.6	10	1810	-50	36	-0.1	1	-2
-0.008	960	-0.5	0.6	-0.1	-1	2200	3.5	5	-5	0.4	-0.03
-0.5	0.32	-0.05	0.33								
AL96/1260		WS 11B	31	-2	8.4	840	46	24.1	8	13	-0.5
0.34	-0.5	-1	-2	20.2	-2	2130	-50	56	-0.1	1	-3
-0.01	-300	-0.5	-0.1	-0.1	-1	2300	2.6	-3	-5	0.3	-0.06
-0.5	-0.07	-0.05	0.14								
AL96/1261		WS 12	92	-2	1.7	520	52	14.9	5	12	-0.5
0.36	0.6	-1	-2	27.6	-2	1350	-50	63	0.2	1	-2
-0.008	560	-0.5	0.7	-0.1	-1	1700	3.3	6	-5	0.4	-0.03
-0.5	-0.05	-0.05	0.37								
AL96/1262		WS 13	32	-2	1.9	900	32	16.5	4	17	0.5
0.4	0.6	-1	-2	24.4	-2	2050	-50	51	0.3	1.1	-2
-0.008	1000	-0.5	1	-0.1	-1	2800	3.9	8	11	0.5	-0.03
-0.5	0.25	-0.05	0.33								
AL96/1263		WS 13	33	-2	1.8	960	32	16.6	4	15	-0.5
0.37	1.2	-1	-3	22.1	-2	2050	-50	64	0.3	1.2	-2
-0.009	950	-0.5	1.3	-0.1	-1	3000	4	10	-5	0.6	-0.03
-0.5	0.2	-0.05	0.31								
AL96/1264		V6c	11	-2	6.7	340	11	14.1	10	61	-0.5
1.65	4.9	-1	-2	3.67	6	11300	180	38	1.1	4.3	-2
-0.007	830	-0.5	2.8	1.2	-1	720	19	37	19	2.7	0.86
-0.5	1.68	0.29	0.52								
AL96/1265		WS 14	19	-2	1.6	820	21	15	4	10	0.9
0.28	-0.5	-1	-2	24.9	-2	1450	-50	87	-0.1	0.7	-2
-0.006	980	-0.5	0.6	-0.1	-1	2100	2.6	4	-5	0.3	-0.03
-0.5	-0.05	-0.05	0.52								
AL96/1266		WS 15A	38	-2	1.9	1200	25	18.2	3	12	-0.5
0.32	-0.5	-1	-2	20.1	3	1650	-50	61	0.2	0.8	-2
-0.006	1500	-0.5	0.8	-0.1	-1	2600	3.2	6	-5	0.4	-0.02
-0.5	0.22	-0.05	0.55								
AL96/1267		WS 15B	38	-2	2.8	1300	48	21.5	5	15	-0.5
0.32	-0.5	-1	-3	22.8	-2	2720	-50	56	0.6	1	-2

-0.011	1400	-0.5	-0.1	-0.2	-1	2700	3.3	5	-5	0.4	-0.06
-0.5	-0.05	-0.05	0.19								
AL96/1268		WS 16-1A		42	-2	3.1	870	42	15.6	5	20
1.1	0.43	0.6	-1	-3	21.5	7	2830	-50	60	0.2	1.3
-2	-0.009	950	-0.5	1.2	-0.1	-1	2400	5.4	10	-5	0.6
-0.04	-0.5	0.21	0.09	0.29							
AL96/1269		WS 16-1B		20	-2	2.8	760	38	18.4	5	14
-0.5	0.3	-0.5	-1	-3	22.7	-2	1690	-50	56	-0.1	0.9
-2	-0.011	1000	-0.5	0.8	-0.2	-1	1900	2.6	5	-5	0.3
0.39	-0.5	-0.05	-0.05	0.19							
AL96/1270		WS 16A+B		41	-2	2.6	920	35	15.9	4	11
0.8	0.39	0.7	-1	-2	21	7	2190	-50	57	0.2	1.1
-2	-0.008	1200	-0.5	1	-0.1	-1	2100	4.1	5	-5	0.5
-0.03	-0.5	0.22	0.06	0.3							
AL96/1271		WS 17A		72	-2	2.6	850	36	20.3	5	13	1.1
0.44	0.9	-1	-3	20.6	8	2360	-50	66	0.3	1.3	-2
-0.008	730	-0.5	1.2	-0.1	-1	2100	4.9	10	-5	0.5	0.13
-0.5	0.28	0.08	0.27								
AL96/1272		WS 17B		46	-2	1.7	1100	26	21	4	16	0.7
0.33	0.6	-1	-2	18.9	6	2080	-50	65	0.2	1	3
-0.007	1300	-0.5	0.7	-0.1	-1	1900	3.8	7	-5	0.4	-0.03
-0.5	0.27	0.06	0.29								
AL96/1273		WS 18A		45	-2	3.4	740	23	18	4	19	0.8
0.56	0.9	-1	-2	20.6	4	3120	-50	84	0.3	1.6	-2
-0.005	870	-0.5	1.6	0.7	-1	1800	6.2	11	-5	0.7	0.12
-0.5	0.2	0.09	0.56								
AL96/1274		WS 18B		19	-2	2.2	810	37	15.7	4	12	-0.5
0.35	-0.5	-1	-2	16.8	-2	2080	-50	80	0.2	1	-2
-0.007	860	-0.5	0.8	-0.1	-1	1500	3.4	6	-5	0.4	-0.03
-0.5	0.3	-0.05	0.29								
AL96/1275		DS 0-1		32	-2	2	1100	63	12.7	16	15	1.6
0.48	1	-1	-3	27.6	5	2650	-50	170	0.3	1.5	-2
-0.009	-300	-0.5	1.5	1	-1	2100	7.6	14	10	0.7	0.27
-0.5	0.31	0.08	0.29								
AL96/1276		DS 0-2		67	-2	3.9	1200	72	13.8	15	29	2.3
0.76	1.5	-1	-3	23.7	-2	4180	-50	140	0.3	2.5	-2
-0.01	-300	-0.5	2.1	1.3	-1	2000	10	20	-5	1.2	0.27
-0.5	0.4	0.11	0.3								
AL96/1277		DS00		48	-2	3.9	530	39	14.9	10	28	1.5
0.81	1.3	-1	-2	21.2	-2	3950	-50	180	0.5	2.2	-2
-0.007	-300	-0.5	1.8	-0.1	-1	2200	8.9	17	-5	1.1	-0.02
-0.5	0.5	0.09	0.5								
AL96/1278		DS 1		30	-2	-0.5	1000	48	16.3	16	14	3.1
0.43	-0.5	-1	-2	17.8	-2	2190	-50	170	0.3	1.3	-2
-0.008	-300	0.6	1	-0.1	-1	2000	4.1	9	-5	0.5	-0.03
-0.5	0.33	0.07	0.33								
AL96/1279		DS 1		29	-2	2.5	1000	46	17.7	14	19	2.4
0.44	0.6	-1	-2	19.3	-2	2330	89	200	0.2	1.3	-2
-0.008	-300	-0.5	1.1	-0.1	-1	2000	4.9	9	10	0.6	-0.03
-0.5	0.19	-0.05	0.31								
AL96/1280		V6c		15	-2	6.7	380	9	15.5	9	66	1
1.68	4.6	-1	-2	3.31	5	11600	-50	41	1.1	4.4	-2
-0.006	920	-0.5	2.7	0.7	-1	760	20	41	20	2.6	0.8
-0.5	1.65	0.27	0.53								
AL96/1281		DS 2A		19	-2	2.1	1400	33	17.6	26	15	1.1
0.45	0.8	-1	-2	19.9	-2	2180	-50	110	0.3	1.2	-2

-0.005	510	-0.5	1.1	1.3	-1	1900	4.5	9	-5	0.5	-0.03
-0.5	0.46	-0.05	0.55								
AL96/1282		DS 2B	8	-2	2.2	2100	19	23	30	13	1.4
0.46	0.9	-1	-2	16.1	-2	2460	-50	100	0.2	1.3	-2
-0.008	-300	-0.5	1	-0.1	-1	2100	4.4	8	9	0.6	-0.03
-0.5	0.22	-0.05	0.26								
AL96/1283		DS 3	36	-2	2.4	1200	20	14	20	13	1.6
0.44	0.7	-1	-2	18.2	-2	2380	91	100	0.3	1.5	-2
-0.007	-300	-0.5	1.4	-0.1	-1	2000	5.7	11	-5	0.7	-0.03
-0.5	0.24	0.07	0.32								
AL96/1284		DS 4A	29	-2	2.3	1500	33	18.9	10	18	1.4
0.47	0.8	-1	-2	16.2	-2	2360	-50	150	0.3	1.3	-2
-0.01	860	-0.5	1.3	-0.1	-1	2000	5.6	11	-5	0.7	-0.03
-0.5	0.31	0.05	0.28								
AL96/1285		DS 4B	22	-2	1.7	1600	16	21.1	9	13	1.6
0.42	0.9	-1	-2	15.9	-2	2210	-50	160	-0.1	1.2	-2
-0.007	670	-0.5	0.9	-0.1	-1	1800	4.1	7	-5	0.5	-0.03
-0.5	0.26	-0.05	0.28								
AL96/1286		DS 5A	27	-2	1.9	700	22	11.8	8	12	1.9
0.39	0.7	-1	-2	26.3	-2	2100	130	230	0.2	1.1	-2
-0.007	560	-0.5	0.9	-0.1	-1	1900	4.1	8	-5	0.5	-0.03
-0.5	0.24	0.05	0.34								
AL96/1287		DS 5B	6	-2	-0.5	880	18	16.8	9	16	0.9
0.35	-0.5	-1	-2	26.6	-2	2090	-50	210	0.2	1	-2
-0.008	-300	-0.5	0.6	-0.1	-1	2100	3	9	6	0.4	-0.03
-0.5	0.2	-0.05	0.26								
AL96/1288		DS 6	42	-2	1.4	1900	18	18.5	18	13	1.1
0.26	-0.5	-1	-2	14.3	-2	1400	-50	51	0.1	0.8	-2
-0.006	440	-0.5	0.7	-0.1	-1	1900	2.9	6	-5	0.3	-0.03
-0.5	0.17	-0.05	0.36								
AL95/1289		DS 7	48	-2	2.8	1500	23	16.4	16	23	1.4
0.71	1.5	-1	-2	19.6	-2	3800	-50	120	0.3	2.1	-2
-0.007	820	-0.5	1.6	0.8	-1	1700	8.1	15	-5	1	0.21
-0.5	0.43	0.1	0.35								
AL95/1290		DS 8	50	-2	-0.5	1900	24	18.6	8	10	1.7
0.31	-0.5	-1	-2	18.4	-2	1740	-50	180	-0.1	0.9	-2
-0.006	1400	-0.5	0.7	-0.1	-1	1600	3.4	6	-5	0.4	-0.03
-0.5	0.29	0.06	0.36								
AL95/1291		DS 9	30	-2	1.3	670	20	16.3	7	13	1.2
0.42	0.8	-1	-2	19.1	-2	2310	-50	170	0.2	1.3	-2
-0.007	910	-0.5	1.2	0.5	-1	1600	4.9	8	-5	0.6	0.2
-0.5	0.22	0.06	0.33								
AL95/1292		DS10	50	-2	2	1200	27	13.4	10	12	1.3
0.35	0.5	-1	-2	20	-2	1880	84	230	0.2	1	-2
-0.006	920	1	0.8	-0.1	2	1800	3.4	7	-5	0.4	-0.03
-0.5	0.39	-0.05	0.37								
AL95/1293		DS11A	32	-2	2.6	820	27	16.6	14	17	1.7
0.54	0.9	-1	-2	20	-2	3240	78	160	0.2	1.5	-2
-0.006	-300	-0.5	1.5	-0.1	-1	2400	6.2	11	-5	0.8	-0.02
-0.5	0.31	-0.05	0.37								
AL95/1294		DS11B	23	-2	2.5	900	32	15.9	17	16	1.5
0.36	0.8	-1	-3	23.2	-2	2390	-50	180	0.3	1.1	-2
-0.01	660	-0.5	0.7	-0.2	-1	2100	3.6	10	-5	0.4	-0.04
-0.5	0.24	-0.05	0.16								
AL95/1295		DS12	22	-2	1.5	1100	34	13	15	9	2.5
0.24	0.6	-1	-2	26.7	-2	1450	-50	360	-0.1	0.7	-2

-0.007	570	1.7	0.7	-0.1	-1	1900	2.6	6	-5	0.3	-0.03
-0.5	0.27	0.07	0.38								
AL95/1296		DS13	39	-2	2.2	1500	21	15	14	17	1.1
0.56	1.2	-1	-2	21.1	-2	2960	130	110	0.2	1.4	-2
-0.007	-300	-0.5	1.6	-0.1	-1	2100	6.2	10	-5	0.7	-0.03
-0.5	0.35	0.09	0.35								
AL95/1297		DS14	28	-2	1.9	820	14	15.8	10	9	1
0.27	0.5	-1	-2	20.4	-2	1550	-50	170	-0.1	0.7	-2
-0.006	-300	-0.5	0.8	-0.1	-1	2100	2.6	4	-5	0.3	-0.03
-0.5	0.19	-0.05	0.36								
AL95/1298		DS15	31	-2	2.4	920	59	15.9	17	19	1.6
0.58	-0.5	-1	-2	21.5	-2	3010	110	120	0.2	1.7	-2
-0.007	-300	-0.5	1.6	-0.1	-1	1300	6.7	11	-5	0.8	-0.03
-0.5	0.51	0.08	0.33								
AL95/1299		DS16A	47	-2	1.4	1300	16	18.1	17	12	2.4
0.4	-0.5	-1	-2	21.5	-2	2460	73	410	0.3	1.1	-2
-0.006	720	-0.5	1.4	-0.1	-1	1900	4.4	8	-5	0.5	0.19
-0.5	0.16	-0.05	0.46								
AL96/1300		DS16B	20	-2	2	1600	14	19.2	17	17	1.9
0.37	-0.5	-1	-2	20	-2	1940	82	410	0.2	1	-2
-0.007	830	-0.5	0.8	-0.1	-1	1400	3.7	6	-5	0.4	-0.03
-0.5	-0.05	0.06	0.26								
AL96/1301		DS17	38	-2	2.6	1200	13	20.7	13	21	1.3
0.57	1	-1	-2	13.6	-2	3340	-50	120	0.3	1.7	-2
-0.005	880	-0.5	1.5	-0.1	-1	1600	7	14	8	0.8	0.15
-0.5	0.37	0.09	0.51								
AL96/1302		DS18A+B		21	-2	1.2	1100	12	17.7	12	15
2.2	0.29	-0.5	-1	-2	20.3	-2	1630	-50	320	-0.1	0.8
4	-0.006	670	-0.5	0.7	-0.1	-1	1500	3	6	-5	0.4
-0.03	-0.5	0.13	-0.05	0.35							
AL96/1303		WB 0	19	-2	-0.5	300	9	8.5	2	4	-0.5
0.12	-0.5	-1	-2	31.3	6	668	-50	110	-0.1	0.3	-2
-0.005	1000	-0.5	0.2	-0.1	-1	1800	1.2	-3	-5	0.1	-0.02
-0.5	-0.05	-0.05	0.51								
AL96/1304		WB00	39	-2	2.3	590	24	15.4	7	14	1
0.36	0.6	-1	-2	22.1	7	2180	-50	92	0.2	1	-2
-0.007	1000	-0.5	0.9	-0.1	-1	2000	4.1	8	11	0.4	-0.03
-0.5	-0.05	-0.05	0.3								
AL96/1305		WB00	32	-2	2	610	22	15.5	7	9	1.3
0.36	0.6	-1	-2	19.9	5	2120	-50	110	0.2	1.1	-2
-0.007	880	-0.5	0.9	-0.1	-1	2200	3.9	10	-5	0.5	-0.03
-0.5	0.31	0.08	0.3								
AL96/1306		V6c	14	-2	5.8	380	9	14.6	9	65	0.8
1.68	4.6	-1	-2	3.36	6	11400	-50	40	1	4.2	-2
-0.005	1000	-0.5	2.7	1.4	-1	700	19	40	21	2.7	0.85
-0.5	1.67	0.28	0.54								
AL96/1307		WB 1A	30	-2	1.7	1100	19	16.2	4	15	0.6
0.45	0.6	-1	-2	16.2	-2	2500	-50	66	0.2	1.2	-2
-0.007	1100	-0.5	1.2	-0.1	-1	2500	4.9	10	-5	0.6	-0.03
-0.5	0.27	-0.05	0.34								
AL96/1308		WB 1B	21	-2	-0.6	1400	29	18.9	6	-1	1.1
0.36	-0.5	-1	-2	17.4	-2	1690	-50	85	-0.1	0.8	-2
-0.014	820	-0.5	-0.1	-0.2	-1	2500	2.9	-3	-5	0.3	-0.06
-0.5	-0.06	-0.05	0.12								
AL96/1309		WB 2A	37	-2	2.2	1300	23	20.1	4	16	-0.5
0.46	-0.5	-1	-2	12.4	-2	2550	-50	54	0.3	1.3	-2

	-0.007	1400	-0.5	1.2	-0.1	-1	2500	4.8	9	-5	0.6	-0.03
	-0.5	0.25	0.07	0.29								
AL96/1310			WB 2B	19	-2	-0.5	1300	19	19.9	4	6	-0.5
	0.27	0.7	-1	-2	16	-2	1490	-50	66	0.2	0.8	-2
	-0.007	1500	-0.5	0.8	-0.1	-1	2100	2.6	-3	-5	0.3	-0.03
	-0.5	0.19	-0.05	0.25								
AL96/1311			WB 3A	32	-2	1.4	560	29	18.7	3	11	0.6
	0.39	0.7	-1	-2	15	11	1950	-50	44	0.2	1	-2
	-0.006	760	-0.5	1	-0.1	-1	2500	4	8	-5	0.5	-0.03
	-0.5	0.19	0.06	0.47								
AL96/1312			WB 3B	24	-2	1.5	660	21	20.1	3	5	1
	0.19	-0.5	-1	-2	15	-2	940	-50	37	-0.1	0.4	-2
	-0.007	930	-0.5	0.5	-0.1	-1	2000	1.6	-3	7	0.2	-0.03
	-0.5	-0.05	-0.05	0.25								
AL96/1313			WB 4A	22	-2	1.5	880	32	17.2	3	11	2.7
	0.28	0.5	-1	-2	20.4	10	1620	-50	42	0.2	0.8	-2
	-0.006	1100	-0.5	0.8	-0.1	-1	2100	3.1	9	-5	0.4	-0.03
	-0.5	-0.05	-0.05	0.41								
AL96/1314			WB 4B	14	-2	-0.5	910	23	19.5	2	6	-0.5
	0.17	-0.5	-1	-2	23.1	-2	811	-50	37	-0.1	0.4	-2
	-0.006	1100	-0.5	-0.1	-0.1	-1	2000	1.4	-3	-5	0.2	-0.03
	-0.5	-0.05	-0.05	0.3								
AL96/1315			WB 5A	27	-2	4.1	1300	48	19	7	26	1.3
	0.86	1.2	-1	-2	14.8	-2	4030	-50	64	0.4	2.4	-2
	-0.008	950	-0.5	2.5	-0.1	-1	2300	11	21	5	1.3	0.33
	-0.5	0.67	0.12	0.29								
AL96/1316			WB 6	18	-2	2.3	710	21	18	3	10	0.6
	0.35	0.8	-1	-2	16.2	3	1740	-50	45	0.3	1	-2
	-0.005	790	-0.5	0.9	0.5	-1	1600	3.9	7	-5	0.5	0.17
	-0.5	0.24	-0.05	0.53								
AL96/1317			WB 7	50	-2	1.6	640	44	19.6	4	8	1
	0.31	0.9	-1	-2	18.5	5	1680	-50	42	0.2	0.9	-2
	-0.007	820	-0.5	0.6	-0.1	-1	1400	3.3	5	6	0.4	-0.03
	-0.5	-0.05	-0.05	0.32								
AL96/1318			WB 8	30	-2	3	1400	26	20.1	3	10	0.8
	0.32	-0.5	-1	-2	13.9	-2	1610	52	43	0.3	0.9	-2
	-0.006	1000	-0.5	0.8	-0.1	2	2000	3.4	7	-5	0.4	-0.02
	-0.5	-0.05	0.07	0.37								
AL96/1319			WB 9	45	-2	1.6	1100	23	15.7	4	13	-0.5
	0.35	0.6	-1	-2	19.4	6	1890	62	65	0.1	1	-2
	-0.006	930	-0.5	0.9	-0.1	-1	2200	3.5	6	-5	0.5	-0.03
	-0.5	0.21	0.06	0.33								
AL96/1320			WB10	22	-2	1.7	520	28	15.6	3	9	1
	0.26	-0.5	-1	-2	20.1	-2	1240	-50	62	0.1	0.7	-2
	-0.006	-300	0.5	0.6	-0.1	-1	1800	2.5	6	-5	0.3	-0.03
	-0.5	0.1	-0.05	0.35								
AL96/1321			WB11	55	-2	5.3	1000	28	18.4	9	15	1.6
	0.34	0.6	-1	-2	17	7	2140	74	110	0.3	1	-2
	-0.007	740	-0.5	0.6	-0.1	-1	1900	3.7	7	-5	0.4	-0.03
	-0.5	0.25	-0.05	0.33								
AL96/1322			WB12	19	-2	-0.5	650	11	19.3	3	8	-0.5
	0.18	0.5	-1	-2	25.4	-2	1180	-50	53	0.2	0.5	-2
	-0.005	1400	-0.5	0.5	-0.1	-1	1700	2.1	4	-5	0.3	0.1
	-0.5	0.14	-0.05	0.57								
AL96/1323			WB13	19	-2	1.6	530	23	17	3	11	0.7
	0.32	-0.5	-1	-2	22.5	7	1570	-50	52	0.3	0.8	-2

	-0.006	610	-0.5	0.8	-0.1	-1	2200	3.1	6	-5	0.4	-0.02
	-0.5	0.22	0.05	0.43								
AL96/1324			WB14	70	-2	3.5	810	17	14.6	4	12	0.8
	0.38	0.6	-1	-2	22.9	7	2220	-50	81	0.2	1.1	-2
	-0.006	980	-0.5	1.1	-0.1	-1	2200	4.4	10	-5	0.5	-0.03
	-0.5	0.38	0.06	0.36								
AL96/1325			WB15	41	-2	2.4	1500	17	16.3	5	10	1
	0.33	-0.5	-1	-2	14.7	-2	1690	-50	80	0.2	0.8	-2
	-0.006	1000	-0.5	0.9	-0.1	-1	2000	3.3	5	-5	0.4	0.27
	-0.5	0.26	-0.05	0.39								
AL96/1326			WB16A	40	-2	1.4	760	16	17.9	3	12	0.6
	0.32	0.6	-1	-2	17.4	4	1860	-50	59	0.1	0.8	-2
	-0.005	940	-0.5	0.8	-0.1	-1	2200	3.5	5	-5	0.4	-0.02
	-0.5	0.3	-0.05	0.55								
AL96/1327			WB16B	22	-2	1.3	910	18	20.7	3	7	0.6
	0.27	-0.5	-1	-2	19.4	-2	1360	-50	55	-0.1	0.7	-2
	-0.007	1200	-0.5	-0.1	-0.1	-1	1800	2.3	-3	-5	0.3	-0.03
	-0.5	0.31	-0.05	0.28								
AL96/1328			WB17A	17	-2	2.6	720	13	16.4	4	17	0.9
	0.57	0.9	-1	-2	19.7	6	2900	68	71	0.2	1.5	-2
	-0.005	1000	-0.5	1.6	-0.1	-1	2100	6.1	11	-5	0.7	0.16
	-0.5	0.35	0.05	0.56								
AL96/1329			WB17B	13	-2	1.7	840	17	20.5	3	16	-0.5
	0.4	0.7	-1	-2	16.1	-2	1940	-50	59	0.2	1.2	-2
	-0.006	690	-0.5	1	-0.1	-1	1900	3.8	7	6	0.4	0.11
	-0.5	0.23	0.05	0.31								
AL96/1330			WB18A	61	-2	1.2	920	17	19.6	4	15	0.5
	0.4	0.6	-1	-2	16.8	-2	2310	-50	62	0.3	1.2	-2
	-0.006	1200	-0.5	0.9	-0.1	-1	1900	4.1	8	-5	0.5	0.11
	-0.5	0.21	-0.05	0.38								
AL96/1331			WB18A	59	-2	2	850	18	19.9	3	14	0.7
	0.38	-0.5	-1	-2	16.9	6	2300	-50	57	0.2	1	-2
	-0.005	1200	-0.5	1.1	-0.1	-1	1800	4.1	7	-5	0.5	0.15
	-0.5	0.23	0.05	0.38								
AL96/1332			V6c	19	-2	6.6	390	8	14.9	9	63	0.8
	1.69	4.9	-1	-5	4.16	7	11700	-50	43	1.1	4.3	-2
	-0.005	700	-0.5	3	1.1	-1	740	19	38	21	2.8	0.83
	-0.5	1.63	0.3	0.54								
AL96/1333			WB18B	21	-2	1.1	960	17	20.2	3	10	1.2
	0.23	-0.5	-1	-2	14.4	-2	1230	-50	79	0.2	0.7	-2
	-0.006	1200	-0.5	0.9	-0.1	-1	1800	2.7	6	10	0.3	-0.03
	-0.5	0.16	-0.05	0.3								
AL96/1334			HB 0	51	-2	1.6	870	11	15.4	3	16	1.4
	0.39	0.6	-1	-2	21.1	9	2440	-50	250	0.2	1	-2
	-0.005	880	-0.5	1.3	0.5	-1	1900	4.5	9	5	0.5	0.06
	-0.5	0.22	-0.05	0.54								
AL96/1335			HB00-1	29	-2	2.2	310	18	12.2	4	20	1.2
	0.58	0.9	-1	-2	25.1	-2	3090	-50	190	0.2	1.6	-2
	-0.006	530	-0.5	1.6	-0.1	-1	2300	6.3	10	-5	0.7	-0.03
	-0.5	0.26	-0.05	0.37								
AL96/1336			HB00-2	37	-2	4.2	520	20	12.7	5	25	1.2
	0.8	1.3	-1	-2	19.8	-2	4720	-50	170	0.4	2.3	-2
	-0.007	590	-0.5	2.2	0.6	-1	2600	9	18	6	1.1	0.28
	-0.5	0.53	0.1	0.37								
AL96/1337			HB 1	34	-2	2.9	820	25	14.5	4	14	1.5
	0.38	-0.5	-1	-2	17.6	-2	1990	-50	220	0.2	1.1	-2

	-0.007	1000	-0.5	0.9	-0.2	-1	2300	4.6	10	-5	0.5	-0.03
	-0.5	0.32	-0.05	0.3								
AL96/1338			HB 1	35	-2	2.3	740	25	15.9	4	16	1.9
	0.39	0.7	-1	-2	19.8	-2	1860	-50	190	0.2	1.1	3
	-0.008	1200	-0.5	0.8	0.9	-1	2400	4.7	5	-5	0.4	-0.03
	-0.5	-0.05	0.06	0.27								
AL96/1339			V6c	21	-2	7.7	380	9	14.6	9	60	1
	1.62	4.8	-1	-2	3.24	6	11300	-50	40	1.1	4.3	-2
	-0.005	930	-0.5	2.7	1	-1	740	20	41	20	2.8	0.8
	-0.5	0.65	0.28	0.52								
AL96/1340			HB 2	22	-2	1.6	680	17	14.7	3	14	1.1
	0.37	-0.5	-1	-2	16.5	-2	1880	66	150	0.2	1	-2
	-0.005	1200	-0.5	1.2	-0.1	-1	2100	3.8	7	-5	0.5	-0.02
	-0.5	0.25	0.08	0.5								
AL96/1341			HB 3	27	-2	2.9	620	19	17.9	5	21	0.8
	0.58	0.6	-1	-2	11	-2	2870	-50	76	0.2	1.6	-2
	-0.008	900	-0.5	1.4	-0.2	-1	2300	6.2	11	-5	0.7	-0.03
	-0.5	0.42	0.06	0.27								
AL96/1342			HB 4A	25	-2	2	820	18	19.1	4	11	0.8
	0.48	0.9	-1	-2	13.6	-2	2340	-50	100	0.3	1.2	-2
	-0.007	1400	-0.5	1	-0.1	2	2700	4.7	9	-5	0.6	-0.03
	-0.5	0.2	-0.05	0.33								
AL96/1343			HB 4B	27	-2	-0.5	740	16	20.2	3	11	0.6
	0.23	0.8	-1	-2	14.7	-2	1420	-50	110	0.2	0.7	-2
	-0.006	1100	-0.5	0.6	-0.1	-1	2100	2.6	4	-5	0.3	-0.03
	-0.5	-0.05	-0.05	0.3								
AL96/1344			HB 5A	23	-2	1.6	1100	19	18.4	4	14	2.4
	0.4	-0.5	-1	-2	18.7	-2	1870	-50	210	0.2	1.1	-2
	-0.008	1000	-0.5	1	-0.2	-1	2400	3.9	6	-5	0.5	0.24
	-0.5	0.21	0.07	0.28								
AL96/1345			HB 5B	22	-2	-0.5	1300	20	20	3	15	1.6
	0.23	-0.5	-1	-2	13	4	964	-50	160	-0.1	0.6	-2
	-0.007	870	-0.5	0.5	-0.2	-1	1900	2.2	-3	-5	0.3	-0.03
	-0.5	0.15	-0.05	0.27								
AL96/1346			HB 6	23	-2	2.6	510	18	16.5	4	14	1.7
	0.45	0.9	-1	-2	21.7	-2	2380	-50	210	0.2	1.2	-2
	-0.005	790	-0.5	1.2	0.5	-1	2300	4.4	8	-5	0.5	0.18
	-0.5	0.34	0.07	0.55								
AL96/1347			HB 7	18	-2	2.3	1100	21	19.6	4	13	1
	0.33	0.5	-1	-2	20.2	-2	1770	-50	140	0.2	0.9	-2
	-0.006	960	-0.5	0.9	-0.1	-1	1400	4	8	-5	0.4	-0.02
	-0.5	0.14	-0.05	0.36								
AL96/1348			HB 8	43	-2	1.2	710	29	17.1	5	20	0.8
	0.52	0.9	-1	-2	17.5	-2	2900	-50	160	0.3	1.5	-2
	-0.007	1600	-0.5	1.5	-0.1	-1	2000	5.6	10	-5	0.7	0.29
	-0.5	0.41	0.09	0.33								
AL96/1349			HB 9	18	-2	1.6	1000	18	18.2	4	12	1.2
	0.25	0.5	-1	-2	13.6	5	1540	-50	140	0.2	0.8	-2
	-0.006	1500	-0.5	0.7	-0.1	-1	1900	2.9	6	-5	0.3	0.16
	-0.5	0.17	-0.05	0.32								
AL96/1350			HB 10	48	-2	1.7	800	24	16.5	4	15	1
	0.44	1.2	-1	-2	20.4	-2	2870	-50	200	0.4	1.3	-2
	-0.007	1300	-0.5	1	-0.1	-1	2000	5	10	-5	0.6	0.29
	-0.5	-0.05	0.06	0.34								
AL96/1351			HB 11	24	-2	2.2	690	25	15.3	5	25	1.3
	0.54	0.7	-1	-2	16.3	-2	3300	-50	95	0.3	1.7	-2

-0.007	1200	-0.5	1.3	-0.2	-1	2100	5.8	10	-5	0.8	-0.03
-0.5	0.25	-0.05	0.27								
AL96/1352		HB 12	26	-2	-0.5	650	28	16.4	5	18	1
0.46	0.7	-1	-2	18.7	-2	2370	-50	150	0.2	1.2	-2
-0.007	1200	-0.5	1.4	-0.2	-1	2400	4.5	7	-5	0.6	-0.03
-0.5	0.27	-0.05	0.28								
AL96/1353		HB13A	45	-2	2.1	1100	15	14	3	21	0.8
0.5	0.7	-1	-2	15	-2	2620	-50	130	0.1	1.4	-2
-0.005	1400	-0.5	1.3	-0.1	-1	2000	5.9	11	-5	0.6	0.2
-0.5	0.33	0.08	0.5								
AL96/1354		HB13B	41	-2	2.8	1100	18	15	3	14	1.1
0.33	0.7	-1	-2	19.1	5	2070	93	120	0.2	1.1	-2
-0.007	1300	-0.5	1	-0.1	-1	1400	3.7	7	-5	0.5	-0.03
-0.5	-0.05	-0.05	0.26								
AL96/1355		HB 14	28	-2	2.2	800	35	19.6	5	24	1.1
0.46	0.9	-1	-2	16.5	-2	2690	-50	140	0.3	1.4	-2
-0.007	1500	-0.5	1.3	-0.1	-1	2400	5.4	7	-5	0.6	0.3
-0.5	-0.05	-0.05	0.31								
AL96/1356		HB15	54	-2	2.3	610	23	16	3	14	1.1
0.38	0.6	-1	-2	21.1	-2	2360	-50	180	0.2	1.2	4
-0.005	1100	-0.5	1.1	-0.1	-1	2200	4.4	6	-5	0.5	0.19
-0.5	0.28	-0.05	0.47								
AL96/1357		HB16A	31	-2	2.8	700	28	16.2	4	25	0.7
0.54	0.9	-1	-2	20.4	-2	3410	-50	200	0.3	1.6	-2
-0.007	1400	-0.5	1.2	-0.1	-1	1700	5.7	9	-5	0.7	-0.03
-0.5	0.31	0.09	0.29								
AL96/1358		HB16B	12	-2	-0.5	690	23	15.2	3	15	0.9
0.33	-0.5	-1	-2	26.3	3	1580	100	210	0.1	0.8	-2
-0.007	930	-0.5	0.9	-0.1	-1	1000	2.7	6	-5	0.3	-0.03
-0.5	-0.05	-0.05	0.26								
AL96/1359		HB17A	90	-2	2.3	1100	21	13.4	4	19	1.4
0.5	1.1	-1	-2	21.2	-2	2750	-50	140	0.2	1.4	-2
-0.005	1600	-0.5	1.5	0.4	-1	2100	5.8	11	-5	0.6	-0.02
-0.5	0.35	0.07	0.5								
AL96/1360		HB17B	18	-2	1.3	1100	20	19.1	4	18	0.7
0.36	0.9	-1	-2	18.1	-2	2380	-50	130	0.2	1.2	-2
-0.008	1200	0.8	0.9	-0.1	-1	2000	3.7	6	-5	0.4	0.19
-0.5	0.34	-0.05	0.24								
AL96/1361		HB18A	44	-2	2.5	790	15	13.6	4	20	0.9
0.49	0.9	-1	-2	20.5	-2	2790	-50	160	0.3	1.5	-2
-0.005	810	-0.5	1.2	-0.1	-1	3000	5.5	9	-5	0.7	-0.02
-0.5	0.36	-0.05	0.54								
AL96/1362		HB18B	13	-2	1.6	1000	21	17.3	3	17	0.9
0.35	-0.5	-1	-2	19.8	-2	1840	-50	170	0.2	1	-2
-0.007	1300	-0.5	0.9	-0.1	-1	2700	3	5	-5	0.3	0.18
-0.5	-0.05	-0.05	0.25								
AL96/1363		DB 0	207	-2	-0.5	1100	29	17.1	11	15	2.6
0.28	-0.5	-1	-2	27.3	6	1540	-50	320	0.1	0.8	-2
-0.007	650	-0.5	0.5	-0.1	-1	1700	3.1	5	-5	0.3	-0.03
-0.5	-0.05	-0.05	0.28								
AL96/1364		DB00-1	62	-2	2.9	790	18	16	6	24	2.3
0.72	1.3	-1	-2	18.9	2	3580	51	160	0.4	2	-2
-0.005	910	-0.5	1.9	0.5	-1	1700	7.9	17	10	0.9	0.24
-0.5	0.38	0.1	0.49								
AL96/1365		DB00-2	64	-2	1.4	670	19	14.2	7	16	2.7
0.4	0.9	-1	-2	21.8	-2	2440	-50	200	0.3	1.2	-2

-0.006	810	-0.5	1.3	-0.1	-1	1600	4.3	9	-5	0.5	-0.03
-0.5	0.29	-0.05	0.33								
AL96/1366		DB 1A	46	-2	1.9	1200	27	15.5	11	18	1
0.39	-0.5	-1	-2	18.6	-2	1940	100	150	0.3	1.1	-2
-0.007	650	-0.5	1	0.7	-1	1500	3.8	8	8	0.4	0.27
-0.5	-0.05	-0.05	0.32								
AL96/1367		DB 1A	45	-2	2.4	1200	24	16.9	12	11	0.6
0.4	-0.5	-1	-2	19	3	2220	110	110	0.3	1.1	-2
-0.007	700	-0.5	0.8	-0.1	-1	1600	3.9	6	-5	0.5	0.22
-0.5	0.21	0.08	0.31								
AL96/1368		V6c	22	-2	6.5	380	10	14.1	9	65	0.9
1.68	4.5	-1	-2	4.84	5	11200	-50	41	1.1	4.2	-2
-0.005	1000	-0.5	2.7	1.5	-1	780	19	40	21	2.7	0.8
-0.5	1.59	0.28	0.55								
AL96/1369		DB 1B	15	-2	2	1300	20	20.5	14	11	1.1
0.25	-0.5	-1	-2	16.5	-2	1300	150	100	0.3	0.7	-2
-0.007	890	-0.5	0.7	-0.1	-1	1500	2.1	4	-5	0.3	-0.03
-0.5	0.24	-0.05	0.25								
AL96/1370		DB 2A	50	-2	1.9	1100	18	16.3	9	12	1
0.34	0.6	-1	-2	20.4	-2	1650	-50	180	0.2	0.9	-2
-0.007	650	-0.5	0.8	-0.1	-1	1700	3.3	7	-5	0.4	-0.02
-0.5	0.16	0.06	0.54								
AL96/1371		DB 2B	13	-2	2	1400	18	20.8	11	17	0.9
0.34	-0.5	-1	-3	15.9	-2	1930	-50	150	-0.1	1	-2
-0.007	550	-0.5	0.7	-0.1	-1	1500	3.1	5	-5	0.4	-0.03
-0.5	0.17	-0.05	0.21								
AL96/1372		DB 3A	44	-2	2.3	1300	20	19	10	17	1.1
0.47	1.1	-1	-2	14.4	4	2740	77	110	0.4	1.4	-2
-0.006	710	-0.5	1.2	-0.1	-1	2100	5.3	10	-5	0.6	-0.03
-0.5	0.23	0.06	0.36								
AL96/1373		DB 3B	35	-2	1.6	1400	21	19.7	11	15	1.1
0.43	0.7	-1	-2	12.9	5	2220	-50	110	0.2	1.1	-2
-0.007	-300	-0.5	1.1	-0.1	-1	1800	3.8	7	-5	0.5	-0.03
-0.5	0.21	0.05	0.27								
AL96/1374		DB 4	31	-2	1.6	1700	31	19.2	14	23	1.3
0.5	0.7	-1	-3	21.8	-2	2510	-50	170	0.3	1.3	-2
-0.011	1200	-0.5	1.6	-0.2	-1	1600	5.1	13	-5	0.6	-0.04
-0.5	0.35	-0.05	0.17								
AL96/1375		DB 5	48	-2	-0.5	1300	18	20.5	9	14	1.7
0.25	0.9	-1	-2	18.5	-2	1390	-50	170	0.1	0.7	-2
-0.007	740	-0.5	0.7	-0.1	-1	1800	2.7	4	-5	0.3	-0.03
-0.5	0.15	-0.05	0.28								
AL96/1376		DB 6	33	-2	2.1	990	17	18.9	9	14	1.1
0.35	-0.5	-1	-2	16.6	-2	2000	-50	140	0.2	1	-2
-0.006	730	-0.5	0.9	-0.1	-1	1700	3.4	6	-5	0.4	-0.03
-0.5	-0.05	0.06	0.34								
AL96/1377		DB 7-1	40	-2	2.3	640	21	17.9	9	20	1.2
0.4	0.7	-1	-2	16.9	-2	2700	-50	230	0.2	1	-2
-0.006	710	-0.5	1	0.6	-1	1900	4.1	8	-5	0.4	-0.02
-0.5	0.25	-0.05	0.34								
AL96/1378		DB 7-2	57	-2	1.6	470	17	16.4	8	13	1.8
0.28	-0.5	-1	-2	20.4	-2	1680	110	250	0.2	0.7	-2
-0.006	-300	-0.5	0.6	-0.1	-1	1800	2.6	-3	-5	0.3	-0.03
-0.5	0.23	-0.05	0.34								
AL96/1379		DB 8-1	132	-2	1.3	1400	24	23.1	11	19	2.4
0.35	0.8	-1	-2	20.3	-2	2030	-50	300	0.3	1	-2

	-0.007	810	-0.5	1	-0.1	-1	1600	3.7	7	-5	0.4	-0.03
	-0.5	-0.05	-0.05	0.26								
AL96/1380			DB 8-2	42	-2	2	1300	20	21	9	12	2.1
	0.29	-0.5	-1	-2	18	-2	1920	-50	240	0.2	0.9	-2
	-0.006	680	-0.5	0.9	-0.1	-1	1500	3.2	4	-5	0.4	-0.02
	-0.5	0.14	-0.05	0.33								
AL96/1381			DB 9A	103	-2	1.8	960	21	16.4	12	18	1
	0.3	-0.5	-1	-2	20.5	-2	1940	85	190	-0.1	0.9	-2
	-0.007	730	-0.5	0.6	-0.1	-1	2400	3.6	5	-5	0.4	0.19
	-0.5	0.21	-0.05	0.3								
AL96/1382			DB 9B	28	-2	-0.5	930	23	16.4	12	18	-0.5
	0.23	-0.5	-1	-2	17.2	-2	1260	68	170	-0.1	0.6	-2
	-0.006	500	-0.5	0.4	-0.1	-1	1700	2.9	6	6	0.3	-0.03
	-0.5	-0.05	-0.05	0.31								
AL96/1383			DB10A	49	-2	-0.5	1700	18	16.9	24	19	1
	0.33	-0.5	-1	-2	16.3	-2	2030	69	190	0.2	1	-2
	-0.006	760	-0.5	1	0.6	-1	1700	3.9	7	-5	0.4	0.25
	-0.5	0.22	-0.05	0.35								
AL96/1384			DB10B	33	-2	-0.5	1600	17	19.6	20	12	0.9
	0.25	-0.5	-1	-2	20.2	-2	1440	-50	180	0.1	0.7	-2
	-0.007	530	-0.5	0.5	0.7	-1	1200	2.7	7	-5	0.3	-0.03
	-0.5	0.19	-0.05	0.26								
AL96/1385			DB11	33	-2	1.8	1100	18	17	12	16	0.6
	0.26	-0.5	-1	-2	17.7	-2	1570	-50	110	0.2	0.6	-2
	-0.006	570	-0.5	0.8	-0.1	-1	1400	2.9	7	-5	0.3	-0.03
	-0.5	0.21	-0.05	0.36								
AL96/1386			DB12	61	-2	2.5	2600	24	16.9	22	18	1.2
	0.34	-0.5	-1	-2	22.3	-2	1990	100	120	0.3	1	-2
	-0.008	950	-0.5	1	-0.2	-1	2200	4	8	-5	0.4	-0.04
	-0.5	0.18	-0.05	0.25								
AL96/1387			DB12	45	-2	-0.5	2600	20	19	22	20	1.5
	0.35	0.9	-1	-2	20.3	-2	1790	-50	130	0.2	1	-2
	-0.008	810	-0.5	0.8	-0.2	-1	2200	3.8	8	-5	0.5	-0.03
	-0.5	-0.05	-0.05	0.26								
AL96/1388			V6c	30	-2	6	380	10	14	9	60	0.8
	1.65	4.6	-1	-2	3.89	6	11400	-50	40	1	4.1	-2
	-0.005	900	-0.5	2.8	1.5	-1	720	20	40	20	2.7	0.8
	-0.5	1.68	0.28	0.52								
AL96/1389			DB13A	26	-2	-0.5	2100	23	17.6	10	14	0.9
	0.23	-0.5	-1	-2	29.7	-2	1230	-50	220	0.2	0.6	-2
	-0.007	1000	-0.5	0.6	-0.1	-1	1500	2.7	4	-5	0.2	-0.03
	-0.5	0.24	-0.05	0.3								
AL96/1390			DB13B	51	-2	3	840	21	18.3	6	25	1.4
	0.58	1.1	-1	-2	23.4	-2	3210	-50	220	0.2	1.5	-2
	-0.007	890	-0.5	1.6	0.7	-1	2000	5.6	11	-5	0.6	-0.03
	-0.5	0.29	-0.05	0.35								
AL96/1391			DB14	41	-2	-0.5	900	13	12.9	8	14	1
	0.25	-0.5	-1	-2	13.3	-2	1220	75	160	-0.1	0.7	-2
	-0.005	600	-0.5	0.7	-0.1	-1	1400	2.5	5	-5	0.3	-0.02
	-0.5	0.18	-0.05	0.46								
AL96/1392			DB15A	13	-2	1	800	12	12	7	12	-0.5
	0.17	-0.5	-1	-2	12.4	-2	966	-50	150	0.1	0.5	-2
	-0.005	550	-0.5	0.3	-0.1	-1	900	1.4	4	-5	0.2	-0.02
	-0.5	0.14	-0.05	0.36								
AL96/1393			DB15B	19	-2	2.2	1500	22	19.9	13	23	0.9
	0.31	1	-1	-3	21	-2	1580	-50	260	0.3	0.9	-2

	-0.008	860	-0.5	0.7	-0.2	-1	1600	2.6	4	-5	0.3	0.06
	-0.5	0.16	-0.05	0.2								
AL96/1394			DB16A	25	-2	-0.5	1700	18	16.1	11	15	0.6
	0.29	0.8	-1	-2	17.6	-2	1760	56	82	-0.1	0.9	-2
	-0.006	610	-0.5	0.8	-0.1	-1	1900	3.8	7	-5	0.4	-0.03
	-0.5	0.24	-0.05	0.33								
AL96/1395			DB16B	11	-2	1.9	1800	22	20.8	12	20	0.7
	0.3	-0.5	-1	-2	16.3	-2	1470	-50	70	0.1	0.9	-2
	-0.008	700	-0.5	0.8	-0.2	-1	1600	2.4	6	-5	0.3	-0.03
	-0.5	0.27	-0.05	0.21								
AL96/1396			DB17	53	-2	2.3	1300	23	19.8	7	15	1.1
	0.35	0.6	-1	-2	15.8	-2	1910	-50	230	0.2	1	-2
	-0.007	670	-0.5	0.8	-0.1	-1	1900	4.2	8	-5	0.5	-0.02
	-0.5	0.2	0.05	0.36								
AL96/1397			DB18-1A		31	-2	2.5	600	27	18	6	18
	1.4	0.45	0.7	-1	-2	20.2	-2	2570	-50	250	0.3	1.4
	-2	-0.007	400	-0.5	1.2	-0.1	-1	1700	5.4	10	-5	0.6
	-0.02	-0.5	0.25	-0.05	0.33							
AL96/1398			DB18-1B		15	-2	1	580	20	19.6	5	17
	1.4	0.29	0.6	-1	-2	20.9	-2	1740	-50	230	0.2	0.9
	-2	-0.005	520	-0.5	0.7	-0.1	-1	1400	2.9	7	-5	0.3
	-0.02	-0.5	0.18	-0.05	0.37							
AL96/1399			DB18-2	25	-2	1.7	460	23	14.9	4	11	1.8
	0.26	-0.5	-1	-2	20.1	-2	1660	-50	350	-0.1	0.7	-2
	-0.006	540	-0.5	0.6	-0.1	-1	1600	2.6	5	-5	0.3	-0.02
	-0.5	0.19	-0.05	0.35								